OLUME XVIII FEBRUARY, 1918 NUMBER

THE AMERICAN MUSEUM JOURNAL

UNDERSEA STUDIES OF FISHES

THE COAL QUESTION IN THE UNITED STATES

DEMOCRACY AND SCIENCE

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THE AMERICAN MUSEUM JOURNAL

CONTENTS FOR FEBRUARY

Cover, A Characteristic Coral Reef Scene
Copyrighted photograph by W. H. Longley, taken in about ten feet of water at the Tortugas Marine Biological Laboratory of the Carnegie Institution, Washington

Frontispiece, Undersea Among Giant Coral 78
The Dunn diving helmet used by Professor W. H. Longley in submarine exploration work about the coral reefs at Tortugas, Florida

Haunts and Habits of Tropical Fishes ..... W. H. LONGLEY 79
Reef fishes studied at close range in beautiful sea gardens lying less than twenty feet beneath the waters around the Tortugas Islands
Illustrations from photographs by the Author

On the American Fuel Famine ..... CHARLES P. BERKEY 89
Estimates which show that the present coal shortage is a superficial thing and that the United States is well supplied with reserve fuel

The Coal Situation in the United States ..... CHARLES R. VAN HISE 95
Early history of the work of the Federal Fuel Administration

Photography and Ornithology ..... ARTHUR A. ALLEN 101
A series of photographs by the Author, showing the normal bird in its most characteristic pose

Narrative of a Bird Quest in the Vicinity of Cape Horn .... ROLLO H. BECK 111
Conclusion of an article begun in the January JOURNAL concerning the experiences of a bird collector in the Far South
Illustrations from photographs by the Author

The Mounted Skeleton of *Moropus* in the American Museum ..... W. D. MATTHEW 121
Defying the Law of Correlation, this animal of ancient times had the head and neck of a horse or rhinoceros and great claws like a bear
With restoration sketch by Erwin Christman

Democracy and Science ..... DAVID STARR JORDAN 125

Ferns of Tropical Florida ..... JOHN KUNKEL SMALL 127
Where pinelands and hammocks produce ferneries of indescribable beauty
Illustrations from photographs by the Author

On the Use of the Diving Helmet in Submarine Biological Work ..... E. W. GUDGER 135
Studying marine organisms in their natural habitat by means of a simple apparatus worn on the head
Illustrations from photographs by the Submarine Photo Co., Miami

Ernest W. Smith: In Memoriam ..... F. A. LUCAS 139

The Biting Powers of Ants ..... W. L. MCATEE 141
Multitudinous uses of the jaws of ants and their enormous strength in comparison with the size of the insect

A New Type of Mural Painting 149
Discussion of the work of Will S. Taylor at the American Museum of Natural History

Museum Notes 151

MARY CYNTHIA DICKERSON, *Editor*

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Courtesy of Miller-Dunn Company

UNDERSEA AMONG GIANT CORAL

The Dunn diving helmet has been a part of the equipment of the Marine Biological Laboratory of the Carnegie Institution of Washington at the Tortugas, Florida, since 1915, and has been used by Professor W. H. Longley in his submarine exploration work about the coral reefs. He has directed his attention mainly to reef fishes, living several hours among them each day for weeks at a time. This is not Professor Longley in the photograph, but might well be. There is shown the rubber hose reaching to the attendant boat at the surface, also the stream of bubbles of expired air together with the excess of air pumped from above which is escaping under the edge of the hood

—See "On the Use of the Diving Helmet in Submarine Biological Work," page 135

THE AMERICAN MUSEUM JOURNAL

VOLUME XVIII FEBRUARY, 1918 NUMBER 2

Haunts and Habits of Tropical Fishes

OBSERVATIONS OF AN EXPLORER, EQUIPPED WITH A DIVING-HOOD, IN THE UNKNOWN WORLD OF CORAL LABYRINTHS AT THE BOTTOM OF THE SEA

By W. H. LONGLEY

(Goucher College, Baltimore, and the Department of Marine Biology, Carnegie Institution of Washington)

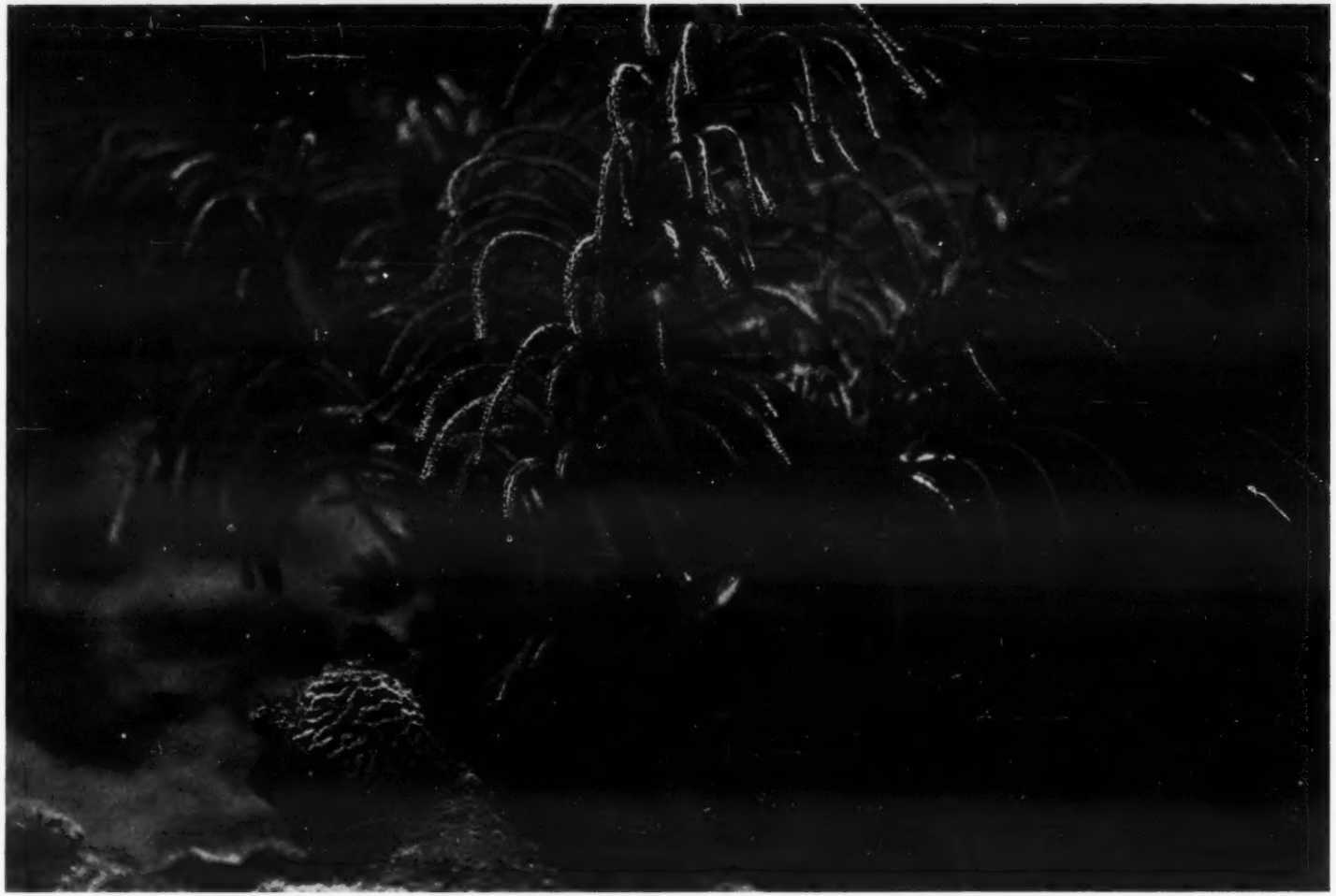
FEW parts of the world seem at once so safely accessible and so little known as certain parts lying in water less than twenty feet deep in tropical seas. Tropical reefs and the reef fauna have been described repeatedly, to be sure, by itinerant naturalists; but no one who has not clothed himself in some sort of diving equipment, clambered over and among the corals, and explored as best he might the labyrinth of passages they enclose, and measured his own height against theirs and that of spreading gorgonians, which in surface view seem so slight and graceful, really knows the reef as it is.

The observer at the surface of the water sees what lies below in little more than two dimensions. From his position he fails further to comprehend the conditions under which the reef-population lives, for water appears to him to be essentially colorless crystal, which blurs no outline, and in which to hide would seem impossible. But when, covered by water, he stands upon the bottom, he speedily realizes how imperfect is his knowledge of the ground he may have studied from above until every detail seemed familiar, and how significant are the changes induced by substituting a very dense for a rarer "atmosphere."

Unimagined depth of shadow lies beneath unsuspected ledges inviting examination but no intrusion. What seemed insignificant depressions become veritable chasms, graven by fretful waves upon an ancient shore now sunken far beneath them. Apparent high steps are abrupt walls, almost beyond scaling, if one's effective weight were not so greatly reduced by his diving equipment that trifling irregularities provide ample hold for foot or hand. Profusely branched, gently swaying gorgonians are waist or shoulder-high, and giant heads of coral tower above, their mass in just proportion to their hoary age.

Over all there hangs a veil of mystery. The water is no longer colorless, crystal-clear, and unsubstantial. Darkening with depth, its soft tints are all pervasive. It blurs and softens every outline. Except when the light is strongest and it is itself most free from sediment, it denies one sight of all but the immediate surroundings, and resolves one's world into a diminutive hollow hemisphere, filled with silence, and on all sides fading into nothingness.

One's narrow field, however, if wisely chosen, may teem with life. It is more than probable that long-spined sea urchins, like animated caltrops, infest the place, twiddle their spines sugges-



AT THE BOTTOM IN A TROPICAL SEA

Gorgonia acerosa with expanded polyps in about fifteen feet of water. The large fish in the center of the field occupied what seemed the identical position twenty-four hours after this picture was taken

tively if one approaches, or make off at a surprising rate of speed to shady places if disturbed. Yellow, brown, or purple gorgonians, heavy with expanded polyps, stand on every side, with an occasional coiled basket star close wrapped about their branches, where its inertness completely belies its amazing power of motion. Large spiny lobsters, torn between distrust and greed, from under mushroomed heads of coral protrude their antennæ and wave them frantically over proffered food. Hermit crabs with heavy shells sit aloft on purple sea fans. With their spoon-shaped fingers spider crabs, ensconced in safe retreats, grub off the encrusting growth of plants and fill themselves to repletion. Others lie safely buried, to venture abroad only under cover of darkness. But manifold as are the forms and habits of other creatures, and particularly of Crustacea, the fish fauna surpasses all in number of species, vivid coloration, variety of adaptations, and, one might almost say, in personality.

The smaller fishes are an inexhaustible source of entertainment. The tiny, blue-striped *Elacatinus oceanops* may be seen at almost any time creeping over the bodies of larger fishes such as grunts and groupers. Its jerky movement seems a source of minor irritation commonly borne with indifference or an air of hopeless resignation, even when the little fellows slip almost within their host's capacious jaws. The severance of relations between the two usually occurs in stereotyped fashion: the larger grows restless and with a characteristic movement halfway between jump and shrug rids itself of its visitor, which then goes back to its accustomed station near the coral heads, or rests upon their vertical faces.

An interesting habit shared by some blennies and their allies is that of living in cavities, which they discover and occupy, or construct for themselves. Perhaps the extreme example is that of *Fierasfer* which establishes itself in the cloaca of large holothurians. *Gnathypops aurifrons,* on the contrary, prepares its own shelter in sandy places where the substratum is sufficiently compact to make successful tunneling possible. Jaws and gaping mouth are its only intrenching tools, but meet its every need. It is found not uncommonly upon the open reef in little colonies, the formation of which is probably due in part to the discontinuous occurrence of suitable bottom rather than to the social instincts of the fishes themselves.

During the day, if undisturbed, *Gnathypops* may be regularly observed resting nearly motionless in a semivertical position above its burrow. When alarmed it retreats into its hole tail foremost and conceals itself until the disturbance outside has ceased. Then it reappears cautiously, its beady black eyes being so situated that it is able to sweep the horizon with minimum exposure. If nothing happens to renew its alarm, it mounts a little farther until its ventral fins are free, rests for a moment in the mouth of its burrow, and finally rises easily and gracefully to its original position.

Still another of these fishes (as yet unidentified) shows a different variation of the tubicolous instinct. It lives in holes, quite possibly worm tubes, which it discovers ready formed in pieces of dead coral upon the bottom. Its most striking structural feature is the immense dorsal fin, which when raised seems nearly as high as the fish is long. Its most interesting habit is that of protruding its body for about half its length from the chamber it occupies, and then elevating and depressing its great fin rapidly, as if it were wigwagging in piscine code. This impression is heightened when two individuals separated by no great distance stand erect and repeat the performance in alternation.

Displayed by less specialized members of the great complex to which these

species belong, one finds a type of reaction from which those just mentioned probably have been derived. There are small blennies, of which *Actaeis moorei* is perhaps an example, which do not seem to have permanent habitations. In an emergency they slip backward into such tiny holes in the coral as may present themselves. In this response there is advantage the exploitation of which seems to have resulted in the use of a greater variety of refuges, their more extensive employment by individuals, and finally in their improvement, or even in their construction, by their occupant.

Of the largest fishes one sees little. Sharks, fortunately for one's peace of mind, are comparatively rare at the Tortugas. Great barracudas, veritable sea wolves, on the contrary, are common, and frequently come swimming about, but are rather shy. Occasionally a jewfish (*Promicrops*) six or seven feet long may come out of hiding with its attendant remoras, scrutinize its strange visitor and withdraw, or one may chance upon a sting ray bedded in the sand with little more than its tail exposed. In that case, if the water has been still for some time, the bottom may be pitted from repeated burials until it has the appearance of having been walked over with snowshoes.

Some fishes so clearly establish themselves at definite places that one may go to the same station day after day, or after an absence of weeks, with almost complete confidence that he will meet well-known individuals within a few minutes at most after his descent. The acquaintance of particular fishes may be cultivated until they do such unheard-of things as eating from one's hand, and permitting one to take liberties with them which would be quite impossible in the beginning. A large Nassau grouper more than twenty inches in length manifested no alarm upon attempted seizure. On the contrary, it would come for food I held in one hand, slipping an indefinite number of times through the fingers of the other or from under the arm with which I attempted to press it to my side. It followed me about when I was studying other fishes, nibbled at outturned pockets, was commonly underfoot when I was seated, and was in general so attentive that without recourse to strategy it could scarcely be coaxed far enough away to have its picture taken.

As one works repeatedly over the same ground, continually extending one's acquaintance, it gradually appears that fishes of different species may establish relations with one another which persist for days. Of such partnerships one of the most interesting I observed was between a red goatfish and a small yellowtail which I saw a number of times hunting for food together. Perhaps, however, it would be more correct to ascribe the initiative in forming the association wholly to the latter, for it seemed to reap all the advantages from the existing arrangement. The former, like others of its kind, went about actively stirring up the sand in search of food, while its satellite stood by, ever on the alert to dash after and snap up the Crustacea routed out by its companion's fluttering barbels.

The variety in the coloration of the fishes is an unfailing source of delight. Whether one looks down upon them through the glassy water, or whether they float into one's field of view through the circumambient haze, they provoke recurrent expressions of admiration. One is thrilled as by the beauty of Aladdin's garden.

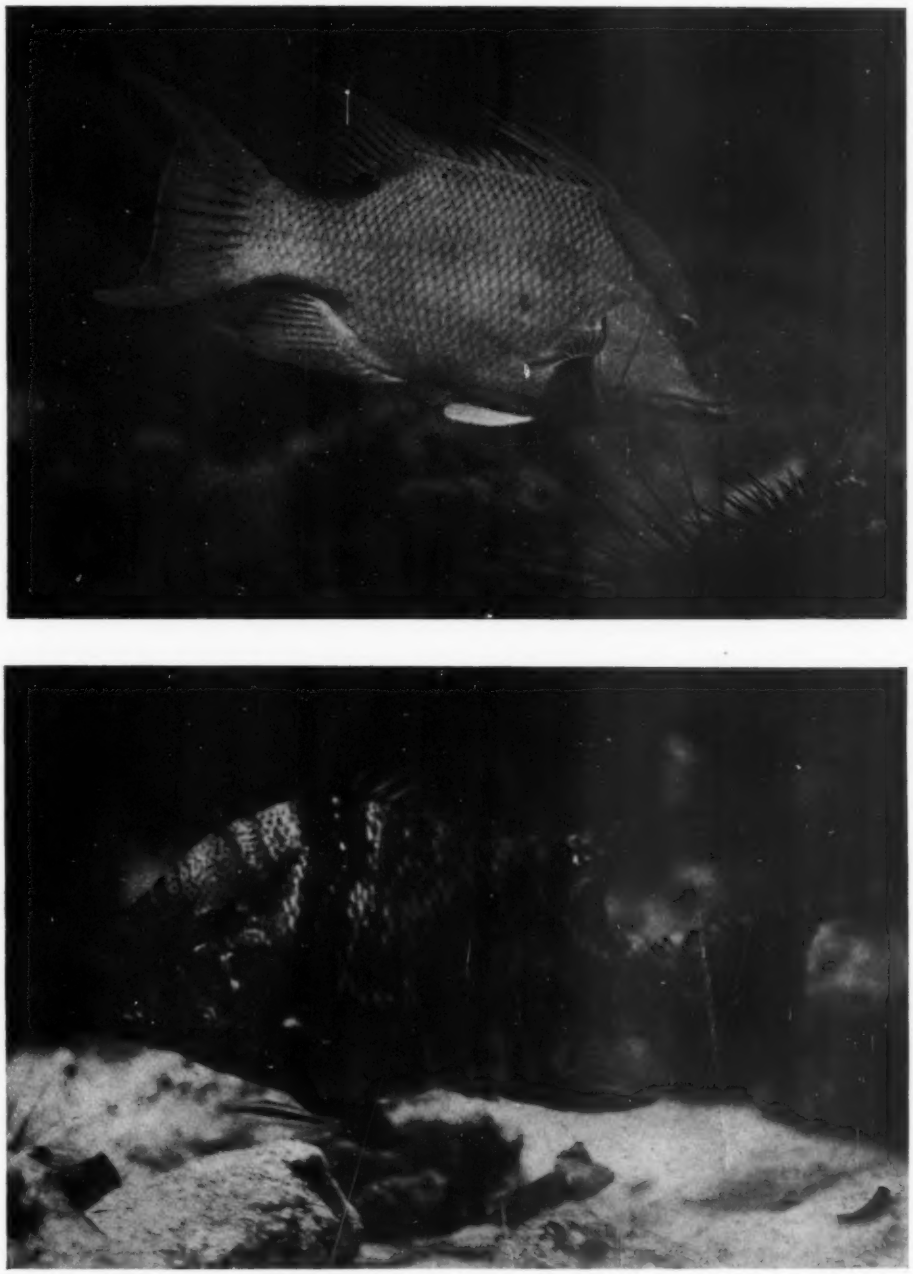
To the bewildered gaze of the novice the various forms flit back and forth aimlessly on the whole, and all appear to be doing much the same thing under the same circumstances. No constant difference in behavior is discovered from species to species with which it would seem reasonable that their color might be correlated. As time passes,

FISH PHOTOGRAPHED AT A DEPTH OF ABOUT EIGHT FEET

These nocturnal fishes commonly rest quietly by day about coral heads and among gorgonians. There are present in this instance gray snappers, yellow grunts, yellow goatfish, with a single parrot fish, and a schoolmaster (*Neomaenis apodus*). Their confusion is due in large measure to a barracuda in their immediate neighborhood

This photograph, taken in from seven to eight feet of water, shows many yellow grunts (*Haemulon sciurus*), three of the related species, the sailor's choice (*H. parra*), two gray snappers (*Neomaenis griseus*), and one yellow goatfish (*Upeneus martinicus*)

Nassau grouper (*Epinephelus striatus*) coming to rest beside the body of a "crawfish" (*Panulirus argus*). Equipped with a diving-hood one may walk about freely among the reef creatures and photograph them amid natural surroundings with much less difficulty than might be anticipated



Hogfishes (*Lachnolaimus maximus*) in different color phases, which may replace each other almost instantaneously. Both are feeding on sea urchins broken for them. The lighter colored individual is over clear sandy bottom, the other over broken bottom among corals and gorgonians. The mottled phase is not, however, conditioned solely by the environment, but tends to appear in resting fishes.

It is of much interest that among creatures which justly have been called "chameleons of the sea," changes in color and shade should enable those displaying them to adjust themselves to their normal surroundings, and to assume the dominant colors of their changing environments, as they pass from place to place

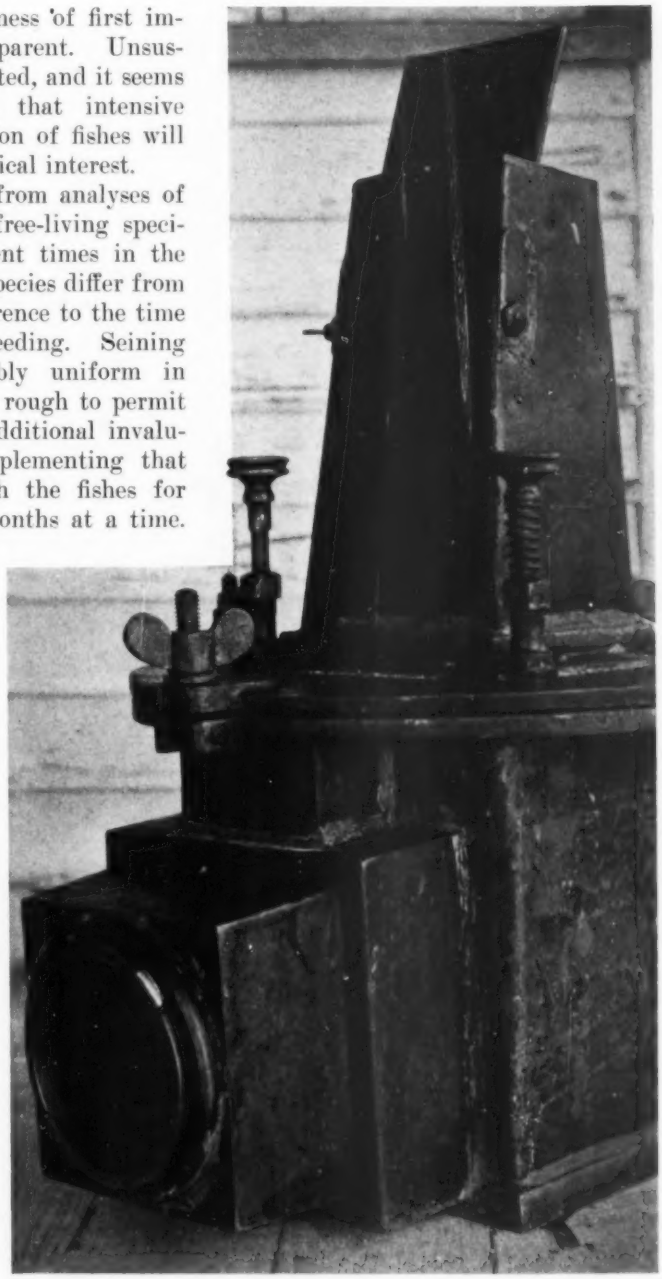
This pair, the goatfish ahead, the yellowtail following, foraged together for days in succession. There is a "slippery Dick" (*Iridio bivittatus*) as well as a second goatfish and a parrot fish in the picture. Some of the difficulties encountered by the submarine photographer are well illustrated in this case. On account of absorption of light by the water, one is obliged to use a wide stop in taking snapshots. As a result, to be sharply in focus objects must be all nearly in one plane. Since the fishes are at perfect liberty to come and go, it is often necessary to wait a long time before the desired configuration appears. Taken in about ten feet of water

Porkfishes and tang against a background of massive coral; sea urchin and sea fan out of focus in the foreground

however, the unsoundness of first impressions becomes apparent. Unsuspected relations are noted, and it seems increasingly probable that intensive studies of the coloration of fishes will yield results of theoretical interest.

It is demonstrable from analyses of stomach contents of free-living specimens taken at different times in the day, that the various species differ from one another with reference to the time and place of their feeding. Seining upon bottoms tolerably uniform in character and not too rough to permit the operation, gives additional invaluable information supplementing that gained by living with the fishes for hours in succession months at a time. In view of data from these various sources, it is not open to question that the groups of fishes one finds swimming together about the larger masses of coral are of the same heterogeneous nature as the crowds one meets on any busy city thoroughfare; they differ from one another in habit as the people differ in occupation.

When the fishes are classified by habit, a number of interesting relations are revealed. Variation in color within the different groups is less than in random samples of the same size from the general human population. Particular colors, in other words, are cor-



Camera container for submarine photography. The mirror projecting in rear view from the top of the focusing hood enables one without bending over to see the doubly reflected image of objects within the field of the camera. The rods with milled heads are for focusing and for releasing the shutter. Both are protected by stuffing boxes. A soft rubber gasket lies between the cover and the body of the box. All other points are permanently sealed by solder or cement. The cubical body of the box is eight inches on the side, and the weight of the whole apparatus in air is about fifty pounds

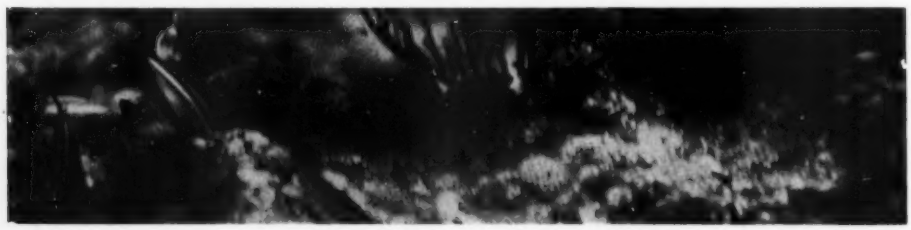
related with specific habits. Red, for example, is almost wholly restricted to nocturnal fishes which lie hidden by day. The greens, on the other hand, characterize such species as live upon the green reef-flats, or swim near the surface in open water. The fishes displaying the most vivid color combinations move in the most varied environments. The colors of all, in brief, appear to conform to a rational and simple system of distribution.

The coloration of many of the species is changeable and may be experimentally controlled. Equipped with a diving-hood one may walk about freely and thus lead carnivorous forms from point to point by offering them food. It is possible under such circumstances to evoke their various color phases at will by selecting the spot to which the creatures are led, and, if desired, to observe at closest range each minute effect of their changed environment. The movements of herbivorous forms are not subject to quite such definite control, but one may walk up to browsing schools of tangs or parrot fishes, follow them about, and secure special information with little effort.

All the creatures may be photographed amid perfectly natural and typical surroundings with much less difficulty than might be anticipated. Hence it has been possible to make encouraging progress in an attempt to secure a pictorial record of the phases assumed by a number of species under controlled conditions.

The two pictures of the hogfish give an idea of the extent to which changes which for all practical purposes are instantaneous may modify the appearance of a species. In nature, so far as I have been able to determine positively from personal observation, such changes are solely dependent upon two factors. The first, and perhaps the chief of these, is the color of the environment into which the fishes move. The second is their activity, or lack of it, for, provided they ever display them, banded patterns appear to characterize the resting condition of fishes.

It is of much interest that among creatures which justly have been called "chameleons of the sea," changes in color and shade should enable those displaying the changes to adjust themselves to their normal surroundings, and to assume the dominant colors of their changing environment, as they pass from place to place. It accords completely with the discovery that the colors of those fishes whose pigmentation is essentially stable are correlated with their habits and in general repeat those characterizing the stations they frequent. Since the conspicuousness of these creatures has not been regarded as of an inferior sort, their changeable coloration provides a physiological test of the truth of the Neo-Darwinian hypotheses advanced to explain animal coloration in terms of natural selection. It may be added that if the observations mentioned are correct and representative, it seems impossible that any explanation of the biological significance of the types of coloration in question which assumes that they possess more than minimal conspicuousness can be correct, for what system of coloration could render an animal more *inconspicuous* than one based upon the principles indicated, if to these be added the countershading the fishes almost universally display?



On the American Fuel Famine

By CHARLES P. BERKEY
Professor of Geology, Columbia University

NEVER before has the average citizen of the United States troubled himself seriously with the question of our coal supply, but the fuel shortage of the past few months has raised the question in almost every mind. The popular conception of the cause of the shortage is certain to involve the question of possible exhaustion of the sources of supply, and raise the specter of a permanent fuel famine. It is, on the whole, a very natural inference in these days of turmoil, when for the first time in our experience many of us begin to realize that the whole world is living literally on the verge of starvation, with threatening complete exhaustion of supposedly endless stores of the commonest necessities of life.

Is, then, our coal also about to fail? And are we to be expected to add to our hunger the further suffering that comes from the relentless cold of our American winters? It is in the hope of being able to give a few facts bearing on this question that the following memorandum has been written.

The Real Question

As a matter of fact, the controlling factors in the present fuel shortage have very little relation to the matter of coal resources or reserves. They are almost wholly simple questions of transportation together with the disturbances of an abnormal demand. These are affected somewhat also by labor conditions and the difficulty of adjustment to the extraordinary living and cost conditions of the time. They might be summarized, perhaps, briefly as follows:

(*a*) Inadequate transportation facilities for this commodity, occasioned by extraordinary requirements for other purposes,
(*b*) An unusually severe winter season,
(*c*) An abnormal demand for coal of certain higher grades for shipping and for export, as well as in the industries of our own country, which are now called on for maximum or increased output,
(*d*) Shortage of efficient labor in all sorts of related or contributory work,
(*e*) And the handicap of increased costs of all kinds.

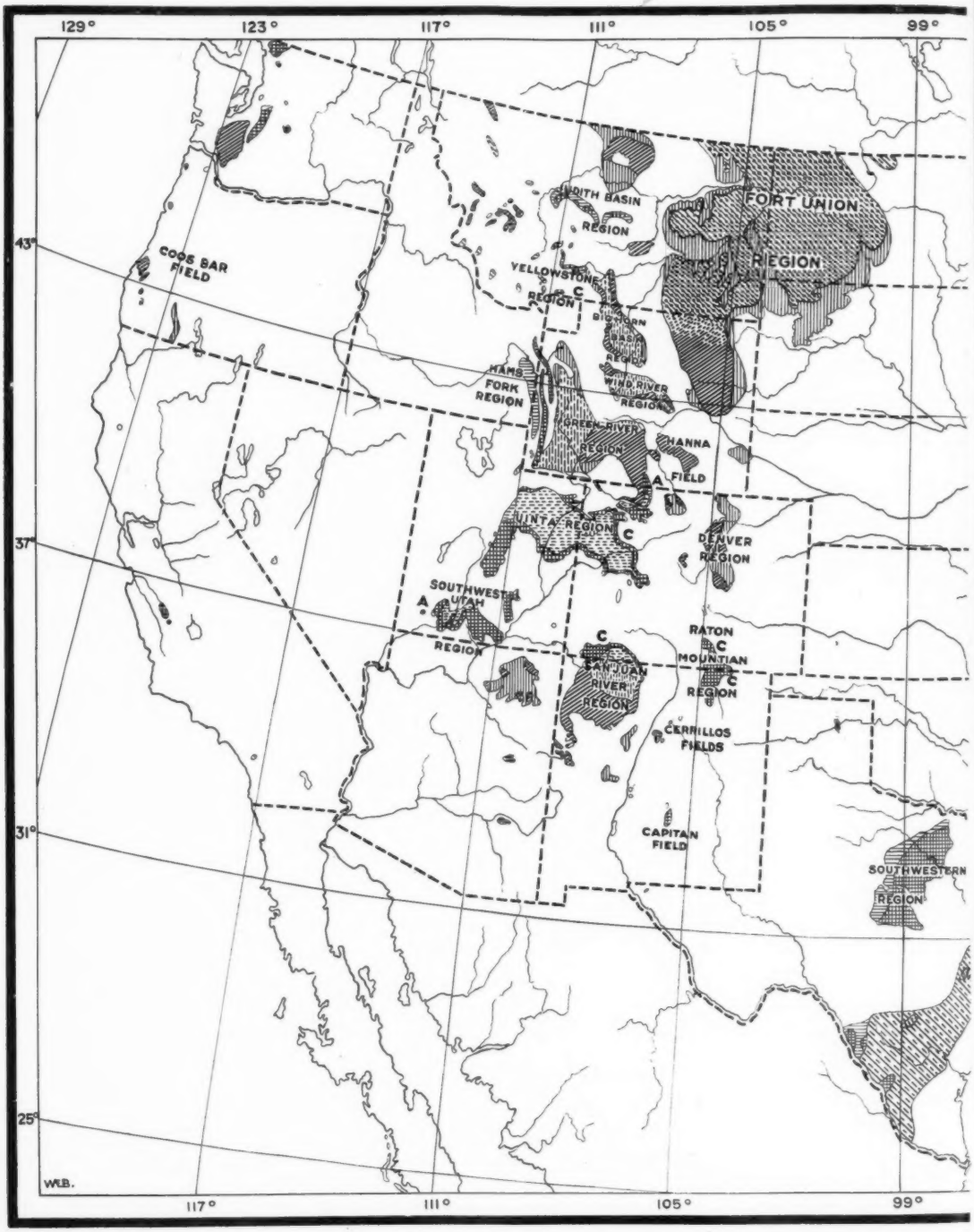
It is not our purpose to discuss these matters. It is only fair to say, however, that there is no real shortage of coal reserves in the ground. America has the most wonderful supply of any country in the world.

The Coal Fields of the United States

America has all grades of coal in very great abundance as compared with the other countries of the world, but certain grades characterize particular fields and therefore this question assumes regional importance to some degree. For example, *anthracite* is the highest grade of coal, but it is confined almost entirely to four comparatively small fields in eastern Pennsylvania, which furnish the market in that grade, although there are a few very small anthracite occurrences in the Rocky Mountain region that have local use. On the other hand, *lignite*, the lowest grade, is very widely distributed, especially in the Great Plains, Rocky Mountain and Gulf regions, and forms an immense reserve which is drawn upon to very small amount in the present market.

The grades recognized by the United States Geological Survey include:

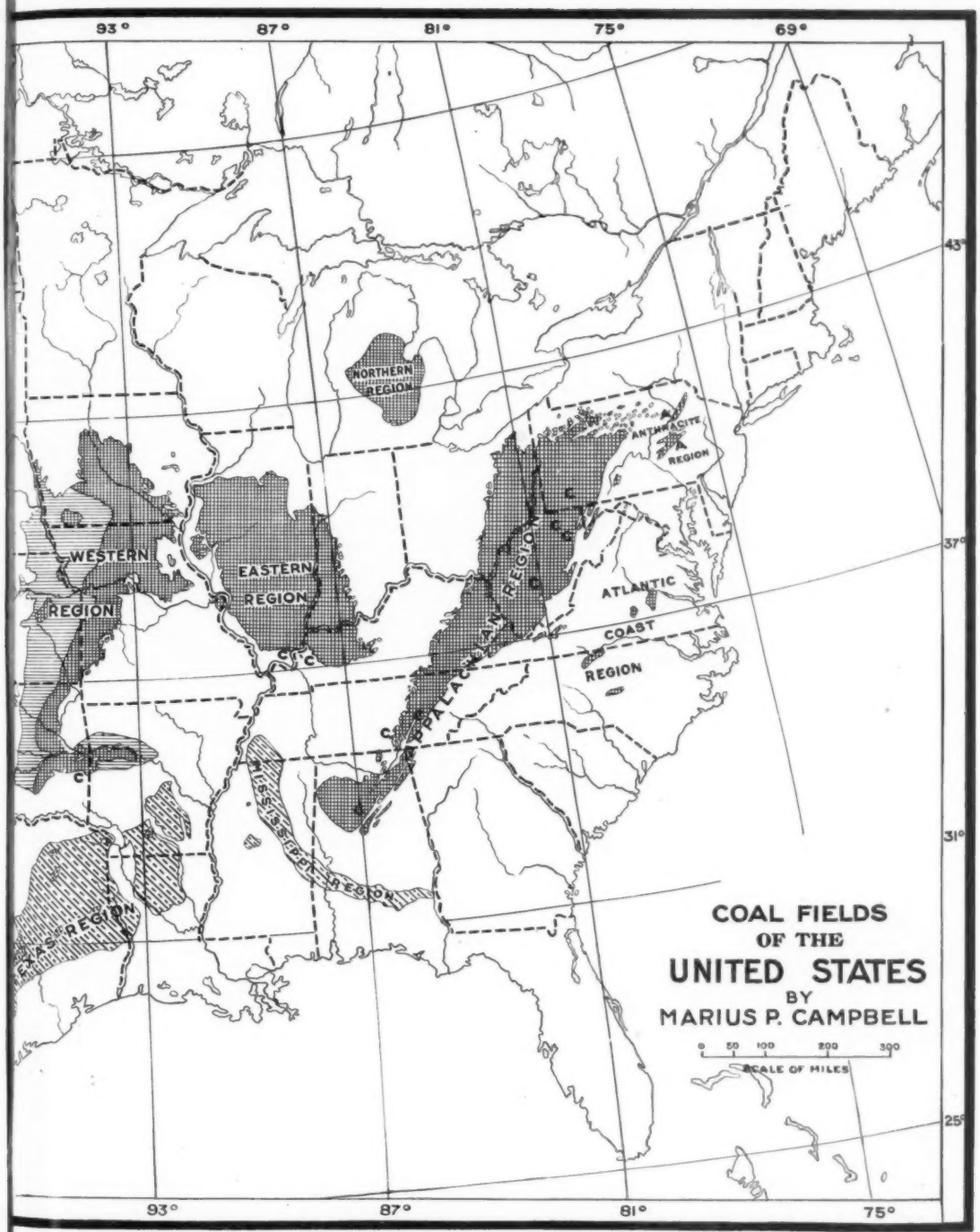
Anthracite, or "hard coal" (the highest grade of all coals),
Semi-anthracite,
Semibituminous (high grade soft coal),
Bituminous, or "soft coal" (the most



Subbituminous Coal

Lignite

In each case (1) indicates areas containing workable coal beds,
(2) areas that may contain workable coal beds, and
(3) areas probably containing workable coal beds under such heavy cover as not to be available at present



Bituminous and Anthracite Coal

Map adapted from *Coal Resources of the World*—an inquiry made upon the initiative of the XII International Geological Congress, Canada, 1913, with the assistance of Geological Surveys and Mining Geologists of different countries

abundantly produced grade of coal for the industries),
Subbituminous (low grade soft coal),
Lignite (the lowest grade of coal, also called "brown coal").

The differences are based chiefly on the ratio between the fixed carbon and the volatile hydrocarbons as shown upon analysis—anthracite being very high in fixed carbon and lignite very low. The anthracites are coals that have suffered more elaborate metamorphism or transformation than the lower grades. Lignites have been least transformed, often preserving the woody structure of the plant accumulation from which they were derived. The bituminous coals are the common steaming coals and make up the bulk of coal production, but great areas of lignitic and subbituminous coals are known and constitute immense low-grade reserves.

The total production of the different grades of coal in 1915—the last year for which returns in this particular are available—was as follows:

Anthracite, 89,048,500 tons, valued at approximately $184,750,000.
Bituminous and Subbituminous and Lignitic coals of all grades, 442,624,426 tons, valued at $502,037,688.

In 1916 the production and value of anthracite were about the same as given above, but the production of bituminous grades reached the enormous total of 509,162,000 tons and was probably worth at least $600,000,000.

The coal fields of the United States, which are literally distributed from coast to coast, are conveniently referred to under the following general names, with grade of coal and areal extent indicated for comparative purposes:

The Coal Fields of the United States

	Area in sq. miles	Production in 1916, in short tons	Estimated remaining available reserve supply in short tons
THE ANTHRACITE FIELDS	480..	88,312,000..	16,000,000,000
(1) Eastern Pennsylvania, Colorado, and New Mexico	29..	53,445..	?
BITUMINOUS FIELDS of the better grade			
(2) Atlantic Coast Triassic Fields (Va., North Carolina)	210..	..	199,000,000
(3) Appalachian Fields (Pa., Ohio, Md., Va., W. Va., Ky., Tenn., Ala., and Ga.)	69,755..	357,366,000..	530,000,000,000
(4) Eastern Interior Fields (Ind., Ill., and western Ky.)	47,000..	91,024,000..	318,000,000,000
(5) Northern Interior Field (Mich.)	11,000..	1,230,000..	11,900,000,000
(6) Western Interior Fields (Ia., Neb., Kan., Mo., Ark., Okla., and parts of Texas)	74,900..	25,650,000..	187,500,000,000
LIGNITIC AND BITUMINOUS FIELDS (chiefly low grade bituminous and lignitic coals)			
(7) Gulf Coast Lignitic Field (Ark. and Tex.)	2,100..	1,100,000..	20,000,000,000
(8) Great Plains and Rocky Mountain Fields (N. Dak., S. Dak., Mont., Wyo., Ida., Colo., N. Mex., Utah)	126,022..	30,041,000..	1,969,000,000,000
(9) Pacific Coast Fields (Wash., Ore., Cal.)	1,900..	3,025,000..	21,800,000,000
(10) Alaska	1,210..	? ..	?

Grand Totals, subdivided on basis of grade

Total original amounts:		Total amount used to date, including allowance for waste, about	15,000,000,000 tons
Lignitic coals	986,855,100,000 tons		
Subbituminous (low grade)	860,331,100,000 tons		
Bituminous	1,314,009,300,000 tons		
Semibituminous (high grade)	43,477,800,000 tons		
Anthracite	20,721,000,000 tons		
	3,225,394,300,000 tons	Balance or reserve supply	3,210,394,300,000 tons

The rate of production at the present time is about 600,000,000 tons per year and is increasing. At this rate, and allowing fifty per cent for waste and loss in mining, it would appear that the United States has a reserve good for something like 2000 years. With growing demands, however, from our own industries and the needs of those parts of the world less favored with such supplies, it is to be expected that the rate of production will increase materially for many years and that final exhaustion is well within that time. The anthracite reserves are being depleted at a much faster rate and probably will not last a hundred years. It is worth noting also that the greatest reserves are in the lowest grades.

As a matter of fact, the world can look forward to the grim necessity in the moderately distant future of utilizing other sources of power and heat, or, failing in that, of adjusting their wants to the modified conditions. It is not at all unlikely that many of the industrial establishments now grouped around the great coal fields will abandon these locations and seek tropical and desert regions where there may be hope of harnessing the wind and sun to furnish power, and where the demands for artificial heat for the comfort of their people are not so pressing. Others will doubtless learn to rely upon the water power of our streams, especially our mountain streams, which will in time be harnessed from source to mouth to furnish power. On many coasts the tides may also be utilized in much the same manner.

Thus the reserve forces of the earth loom up in the future industries of the world. Perhaps in those distant times, the present waste places of the earth, such as our deserts, may blossom with many attractions, forced upon them by the exhaustion of less favored regions.

Coal Reserves of Other Countries

It is of equal interest to compare the coal reserves of the different leading countries of the world, but in that case, of course, many questions beyond our present immediate concern are involved. It has to do with the future of many countries in the economic competition of the world, and may in the long run be one of the deciding factors in world-power, if nations are still to strive for such a thing.

If all grades of coal are included, the available reserves of the different continents are roughly as follows:

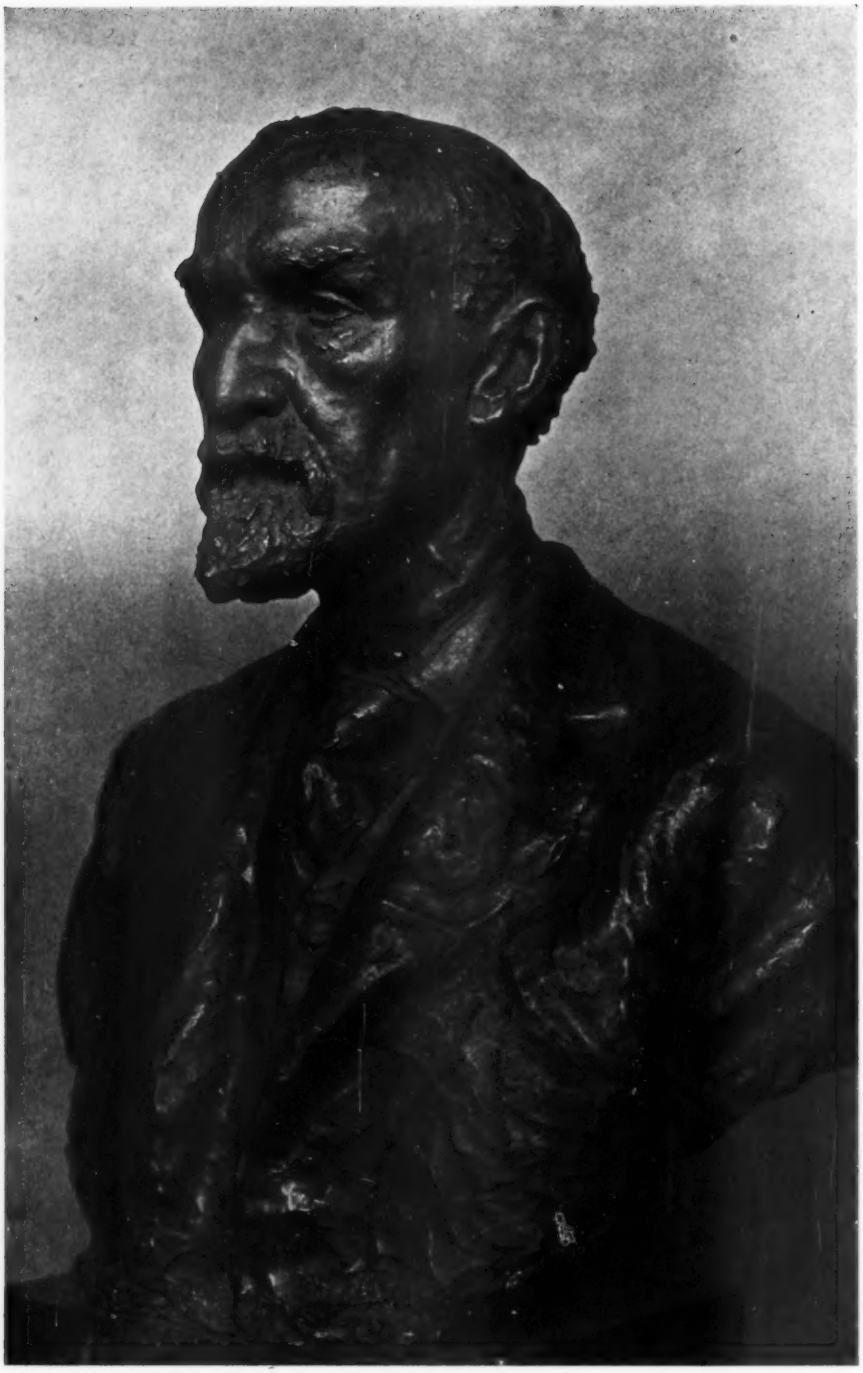
North America	5,073,431,000,000 tons
Asia . . .	1,279,586,000,000 tons
Europe . .	784,190,000,000 tons
Oceania . .	170,410,000,000 tons
Africa . . .	57,839,000,000 tons
South America	32,097,000,000 tons

If these reserves are classified as to grade, the rankings in the different classes are somewhat modified, Asia leading in reserves of anthracite, but there is no large deviation from the original order given. North America's great reserve in all bituminous grades is the striking thing, and places the United States, which is the country carrying the bulk of these supplies, well in the lead in reserve power from this source for the future.

The total available coal reserves of the United States have been estimated at 3,838,657,000,000 tons;[1] the total for the whole world at 7,397,553,000,000 tons. In other words, the United States owns more than half of the apparent world's supply.

It appears therefore that the present coal famine is a very superficial thing and it is a satisfaction from very many different points of view to find that the United States is so well supplied with reserve fuel.

[1] The figures given above have been compiled from the *Mineral Resources of the United States, Mineral Industry* for 1916, and the monograph on *Coal Resources of the World*, published by the International Geological Congress in 1913. These figures are not to be regarded as absolutely accurate to the last ton or dollar but they are found to be serviceable for comparative purposes and they are of the order of magnitude belonging to the various factors of such a problem.



CHARLES R. VAN HISE

President of the University of Wisconsin; trustee of the Carnegie Foundation for the Advancement of Teaching; president of the American Association for the Advancement of Science, 1917. Professor Van Hise is one of the most active and influential of the geologists of the United States in both state and national affairs.

This portrait is from the bronze bust, recently executed by C. S. Pietro for the University of Wisconsin, which was on exhibition for some weeks in Memorial Hall of the American Museum of Natural History

The Coal Situation in the United States

AND THE EARLY HISTORY OF THE WORK OF THE FEDERAL FUEL ADMINISTRATION [1]

"If adequate steps be taken to bring to bear all the potential possibilities of our vast coal and iron resources, in the war of mighty machines driven by the energy of coal, we shall overwhelm the enemy"

By CHARLES R. VAN HISE

President of the University of Wisconsin

OF ALL the countries of the world the United States is the richest known in its coal resources. On October 10 the United States Geological Survey submitted an estimate that the tonnage of bituminous coal in the United States for the year 1917 would be 552,000,000 tons, or 50,000,000 more than in 1916. This is an increase of ten per cent, and as compared with 1915, an increase of about twenty-five per cent. For anthracite the increased production also is estimated at ten per cent as compared with last year.

A survey of the situation made in November, however, indicates that the excess of coal required during the year 1917–18, as compared with the previous year, will be about 100,000,000 tons, thus leaving a gap of 50,000,000 tons between production and requirement.

The great increase in the coal consumption is due mainly to war necessities. Munition plants running twenty-four hours a day require from one third to one half more coal than a year ago. The demands for coal by the government, including the army and navy, have increased by three hundred per cent, or from 2,000,000 to 8,000,000 tons. The public utilities and industries of the country are asking for an increase of coal by one third.

The problem of closing this gap of 50,000,000 tons, between production at the present rate and absolutely necessary consumption, must be met by taking steps to increase the production, by facilitating transportation, and by enforcing the most economical use of available coal. Activities which are unnecessary for the maintenance of military and economic efficiency will have to curtail their supplies as demanded by the necessities of war.

The work of the "Fuel Administration" in the United States during this winter of 1917–18 has been a difficult one. The country is large. Problems of transportation have been many. Labor questions have been difficult of adjustment. What judgment shall be placed upon the work as a whole can be told only in retrospect; and not even then, for we cannot know in the comparisons of various possible methods of procedure, except by supposition, what would have been the difficulties in the untried courses of action.

We start with the fact that about three years ago, in consequence of the war and the revival of industry, there came an increased demand for coal. In 1915 the needs did not require the maximum production of 1913; but the demand during the winter of 1916–17 locally exceeded the available supply, and there resulted hardship and industrial difficulties, especially during the latter part of the winter. With this shortage went rapidly enhancing prices.

[1] From lectures given by President Van Hise at the University of Wisconsin on "Conservation and Regulation in the United States during the World War."

The situation became so acute by June, 1917, that Congress passed a resolution asking the Federal Trade Commission to make an investigation. This Commission found the difficulties to be due more to a lack of cars for transportation and to a shortage of labor than to the incapacity of the mines to produce the necessary amount of coal. The shortage of cars was made even worse by the withdrawal of boats in the Atlantic coast trade from coal transportation, which necessitated shipping coal by rail to the northeastern part of the United States to a greater extent than usual.

Notwithstanding the fact that the estimates made of the amount of coal needed during the year ending June 30, 1917, as compared with the previous year, indicated an increase of about ten per cent, when it came time to make contracts in the early summer of 1917, the prices of coal had increased for large consumers by one hundred to one hundred and fifty per cent, and for small consumers by two hundred to four hundred per cent; indeed, in the early summer of 1917, contracts for many thousands of tons of industrial coal were made for the country contiguous to the interior basins at a rate three to four times that which had been paid the year before.

The fact that coal is basal to all the industry of the country (with the possible exception of agriculture) and its greatly enhancing price, together with the difficulties of transportation, led the Commission to make sweeping recommendations June 19, 1917:

"First, That the production and distribution of coal and coke be conducted through a pool in the hands of a government agency; that the producers of various grades of fuel be paid their full cost of production plus a uniform profit per ton, and

"Second, That the transportation agencies of the United States, both rail and water, be similarly pooled and operated on government account, under the direction of the President, and that all such means of transportation be operated as a unit, the owning corporations being paid a just and fair compensation which would cover normal net profit, upkeep, and betterments."[1]

The coal situation continued to become more and more acute; and during the discussion of the Food Administration bill in Congress, it became so clear that drastic action was necessary regarding fuel, that the Senate inserted a section giving the President the sweeping powers concerning coal[2] suggested by the Commission. He might do either of the things which the commission recommended, or he could make any prices and regulations which he regarded as necessary, even to becoming the exclusive dealer in coal in the United States. This bill became a law on August 10.

The President appointed as Fuel Administrator, Harry A. Garfield, president of Williams College—and thus began the work of the Fuel Administration of the United States.[3]

On August 21, however, and on August 23, before the Fuel Administrator was appointed, the President relieved the general alarm among the people of the country by proclamations fixing the prices of anthracite coal and bituminous coal respectively. The proclamation regarding bituminous coal made $2.00 the basic price in those districts where most cheaply produced—whereas it had leaped to $3.50, to $4.00, to $5.00, and even to $6.00 a ton, sale price at the mines.

These lower prices could not go fully

[1] Report of the Federal Trade Commission on Anthracite and Bituminous Coal, June 20, 1917, Washington, D. C., pp. 20 and 21.

[2] Act of Congress, approved August 10, 1917, entitled "An Act to provide further for the national security and defense by encouraging the production, conserving the supply, and controlling the distribution of food products and fuel."

[3] The organization of the Fuel Administration comprises the organization of the forces at Washington and the organization in the several states. Following the plan of the Food Administration, there has been appointed in each of the states a Federal Fuel Administrator. Through local committees he has complete supervision of local distribution, and in this connection is charged with seeing that the rulings of the President and of the Fuel Administration with relation to prices are observed. The most important duty of the State Fuel Administrators is to see that the supply of fuel in their states is equitably distributed at fair prices.

into effect at once, however, because of previous contracts which had been made, enforcible by law, at much higher figures. But it is extremely probable that, had not this law been passed and the Fuel Administration established, the price of coal for the country would have been at least $2.00 a ton higher than it is, for prices under the competitive plan undoubtedly would have continued to advance. Even at the conservative estimate of $2.00 a ton, the saving on 550,000,000 tons of bituminous coal would be $1,100,000,000.

The prices first fixed have been somewhat modified by the Fuel Administration, acting under presidential approval. In price fixing the Fuel Administration has had the problem to strike the nice balance which will result in the greatest benefit to the people of the United States; a price high enough so that there shall be increased production over that of previous years, but not so high as to place too heavy a burden of cost upon the people. In the case of bituminous coal it is to be noted that the plan has been to fix the price so that each operator shall receive a limited profit. Hence the price is relatively low for coal from the thick seams, easily and cheaply mined, and high for the thin and poor seams from which it is more expensive to mine.

The difficulty of the problem may be illustrated by the very small mine which under ordinary circumstances would not be able to operate. Many of these properties do not even have railroad facilities; these are known as "wagon mines." In consequence of their lack of facilities they cannot produce coal as cheaply as the larger mines with better facilities; hence if they are operated at all, it is necessary for them to receive a high price for their product, which is no better; indeed, is likely to be on the average poorer than that from the large mines.

While differences in prices exist for like products in the same districts, it has been the aim of the Fuel Administration not to make the differentials greater than necessary in order to secure a great production. The larger part of the variations in the prices announced for bituminous coal is due to difference in quality of the coal and to freight differentials.

The practice followed is in complete contravention of economic theories accepted before the war. If a mine were rich and conveniently located it gained a much larger profit per ton than did the poor mine badly located. The owner of the better property gained all the advantages of cheapness of operation and convenience in transportation. Even with the prices fixed, this is still the situation to a considerable extent, but the effect of the price fixing is to reduce the differences between the gains of the rich and the poor mine.

Under the fuel law another method of attack would have been possible. The law authorized the government to be the exclusive buyer and seller of the coal of the country. Had this authority been used, the coal mined would have been sold to the Fuel Administrator at a fair profit for each operator. The coal, then the property of the Fuel Administration, could have been pooled and sold at prices dependent upon its value, taking into account its thermal power, its other qualities, and its position in the country in regard to freight and demand, the prices being fixed so as to return to the Fuel Administration its cost with a sufficient amount to cover administration. Indeed, this was the plan of the Federal Trade Commission, except that the plans of the Commission went even further and required the operation of the mines.

Had this suggested procedure been followed, the inequality of cost of the same quality of coal at the same place would have been avoided. The Fuel Administration, however, would have had the extremely difficult problem of

determining the cost of the production of coal at each mine, dependent as this is upon so many complex factors, including the cost of labor, reduction of the value of the mines due to extractions of material, the depreciation of permanent property, and the interest on the investments. The method would also have placed upon the Fuel Administration the entire burden of apportioning and marketing the coal, a gigantic undertaking. While, therefore, the method of buying coal by the government and pooling the same might be theoretically advantageous, its difficulties were such that the alternative of price fixing was chosen.

One of the most difficult and important of the problems with which the Fuel Administration had to deal was that of apportionment of the available supply of coal. The excess in the demand at various places during the summer of 1917 was very considerable as compared with that of previous years, and there was fear of an absolute shortage on account of insufficient transportational facilities. This situation was accentuated by many manufacturers buying far in advance of their ordinary needs at high prices before the Fuel Administration was established. As illustrating a case of this kind, announcement was made October 2 that the Fuel Administration had discovered at one factory a reserve of 204,000 tons of coal—a year's supply.

Supply for the railroads had to be considered first, that they might operate to their full capacity. In consequence of this fact, on October 11 when it appeared that there was a shortage for the Pennsylvania Railroad, an order was given that a sufficient amount of coal should be furnished so that the road might continue full operation. Similar orders were later made to cover the Baltimore and Ohio, Chesapeake and Ohio, Lehigh Valley, the New York, New Haven and Hartford, and the Central New England railway companies. Under these orders the railways have priority over contracts.

Probably next to the need of the railroads were those of the steel plants and coke plants, in order that these products might be available for munition and other war materials. Therefore the Fuel Administration arranged with the steel mills and coke plants that their necessary needs should be supplied.

Next came the necessity for accumulating coal at the upper lake points before the close of navigation, at Chicago, Milwaukee, Superior, and Duluth. Otherwise it would be necessary to make all-rail shipments from the mines to the consuming place in the territory tributary to the lakes during the winter; and this would make an excessive demand upon cars—the point at which the shortage is most acute. Hence it was necessary that the customary supplies be accumulated at lake points before the end of November, and accordingly it was ordered on October 5 that the accumulation of coal at the upper lake ports should have priority over the accumulation elsewhere. In order to deliver the largest amount of coal, iron ore boats which brought ore down the lakes were compelled to carry coal up the lakes on their return trips.

By giving Great Lake ports priority, the Fuel Administration succeeded by November 2 in accumulating at the lake ports as much coal as usual at that season of the year and the priority order for the Northwest was suspended on lines east of Pittsburgh. Later, further modifications of the priority orders were made, diminishing the amount of coal which went to the Northwest, and on November 30 the priority for the Great Lake ports ceased altogether.

Because of consideration of these three demands the coal supplies became reduced to very low minimums in a number of states, so that alarm was created as to whether the industries

would not be shut down. The situation was especially acute in New England, Ohio, and Michigan, and at the cities of Washington, New York, and Chicago. Whenever a case arose, however, in which it appeared that there was necessity for immediate action in order to relieve the coal shortage to keep industry in operation, there was diverted a sufficient amount of fuel to prevent actual cessation of industry. As illustrative of the sort of action necessary to meet local needs, it may be said that all the coal mined on October 29 in western Pennsylvania, Ohio, Michigan, eastern Kentucky, and West Virginia, was diverted to Ohio and Michigan for distribution to householders. This suspended for one day the priority order under which coal was to go to the lake ports.

To increase the efficiency of the cars of the railroads and to increase the proportion of transportation by water, it was announced on November 7 that the formation of the "Tidewater Coal Exchange" had been approved. This exchange requires all shippers of coal to New England, Baltimore, and Hampton Roads to work through this exchange. This pooling of coal and classifying of grades should result in very greatly increasing the efficiency both for cars and for vessels, since there may be prompt unloading of the cars to any vessel which may be available.

On November 12, in order to relieve the situation in New England and to accumulate coal in advance, it was ordered that all mines having contracts for New England coal should ship maximum amounts for consumption to the states of Maine, Massachusetts, Vermont, Rhode Island, and Connecticut. Thus it became possible in November to begin the accumulation of coal in the central and eastern states, and this accumulation went on rapidly after December 1.

Another aspect intimately associated with the coal for the United States is that for Canada. In consequence of the threatened shortage in the United States, and especially because of the fact that there had not been accumulated coal at the upper lake ports, on September 14, the Fuel Administrator requested the Exports Administrative Board to allow no coal to be exported out of the United States without specific license. On October 1, exportation of fuel to Canada was prohibited to dock companies and all producers and jobbers. Coal on the way to Canada was diverted to the Lake Erie ports for transmission to the upper lakes.

It was not the intention, however, to prevent Canada from having an adequate supply of coal; on the contrary, it is the purpose to furnish coal to that country on the same basis that coal is furnished to the states. Since the output of the mines probably will be about ten per cent more than last year, the plan is to supply Canada during the rest of the year at a rate not to exceed ten per cent more coal than was exported to her last year.

The United States is not the only country which has been confronted with a fuel problem during the war; indeed the same problem has confronted every country engaged in the war, and far more seriously than the United States. Of these countries, England has the largest supply of coal. The government took control of all the coal mines in the United Kingdom, the owners operating the mines. The cost of production is supervised by the government. Thus, for the most important element in the cost, that of wages, all arrangements between the miners and the operators must be approved by the government. The maximum profits on coal are limited. The government requirements are given priority in the distribution of coal and the allotment of coal cars. There is a fifty per cent excess profit tax on the profits of the mines over those of the two best years of 1911, 1912, and 1913.

In France the state has been made the sole depositary of the coal. The general and municipal councils act as dispensing agent. Paris, her suburbs, and other cities have been on coal rations. Coal cards have been issued, so that a central heating plant, a business, or an industrial plant may each receive its fair allotment of the diminished supply of coal. For domestic consumption the quantity of coal per month is based upon the number in the family.

The Italian government produces no coal. It imports all the coal of the country and acts as a clearing house for its distribution.

In Germany the control of coal has been centralized under the government administration.

That there has been fuel shortage in all countries engaged in the war is due largely to the fact that this is a war of coal-driven machines. This war differs from previous wars in that to a vastly greater extent than ever before its prosecution depends upon machines, that is, upon mechanical power instead of man power. This is the first great war which has been fought since the modern concentration of industry. This is indeed a war of machines driven by engines; of gigantic guns, of shells, and other explosive devices; of ships and railroads; and behind these, the necessary multiform supporting manufactures, of which iron is the most important. Any and all of these are possible only through the use of coal.

Coal, therefore, lies back of the war efficiency of all nations. The nations that possess abundant supplies of coal are in an enormously advantageous position. Germany's original strength in coal—and in addition to that she immediately acquired control of the coal fields of Luxembourg, Belgium, and northern France—has given her a superiority in coal power as compared with France and Italy which has placed her in a most advantageous position. Great Britain is the only one of the nations of Europe that has coal power commensurate with that of Germany, and she has been compelled not only to furnish coal for herself, but also to furnish a large amount of coal to the rest of the Allies.

Of all the nations engaged in the war, however, the coal power of the United States is by far the greatest. Indeed our production of coal before the war was more than equal to that of Germany, England, and France combined. But even in the United States the enormously increased demand for coal for railroads, for munition plants, for shipbuilding, and for government use, has made greater requirements than can be met. This limitation, however, is not that of the mines. The limitation to some extent is that of labor at the mines, but to a far greater extent that of the railroads.

The railroads are unable to furnish cars to transport the necessary coal. The magnitude of this task frequently is not appreciated. The tonnage of coal handled by the railroads is greater than that of any other commodity; indeed greater than that of food. About twenty-five per cent of the motive power of the roads is used in handling coal.

As the war continues it is certain that the demand for coal will continue further to increase. Since the production of adequate coal is fundamental in order to dominate, as our coal resources make it possible, in the mighty mechanical contest of winning the war, it is absolutely essential that the railroads shall have sufficient equipment in coal cars and motive power to furnish the necessary amount of coal; and whatever steps are necessary to put the railroads in this situation must be taken. If adequate steps be taken to bring to bear all the potential possibilities of our vast coal and iron resources, in the war of mighty machines driven by the energy of coal, we shall overwhelm the enemy.

PHOTOGRAPHY AND ORNITHOLOGY

A SERIES OF PHOTOGRAPHS REPRODUCED FOR THEIR SCIENTIFIC VALUE, AS EXPRESSING THE NORMAL BIRD IN ITS MOST CHARACTERISTIC POSE

BY ARTHUR A. ALLEN

Assistant Professor of Ornithology, Cornell University

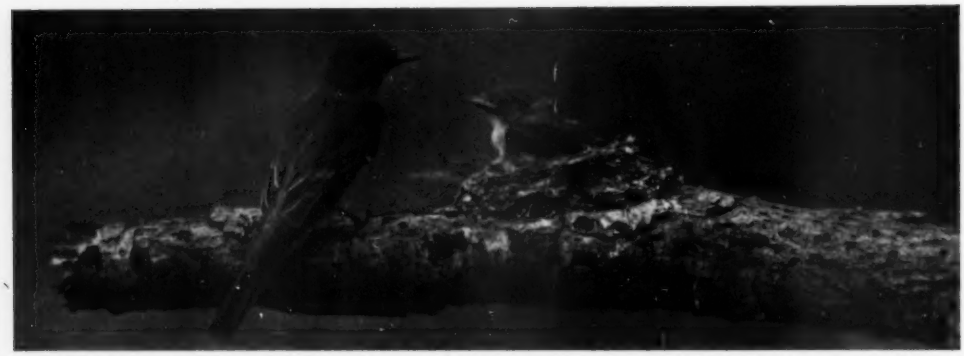
As the study of the living bird assumes a more important place in ornithology, photography becomes increasingly valuable. With the camera, complete and instantaneous records of observations can be made, and accurate representations of the living birds can be preserved. It must not be thought, however, that the camera is infallible. For, while it can reproduce the living bird nearly as realistically as can the art of taxidermy, a poor photograph is more dangerous to ornithological science than a poorly mounted specimen is to a museum, because, with seeming truth, it often conveys an entirely erroneous impression. Technical faults of exposure and lighting, distortion due to foreshortening or due to shallowness of the focal area, render imperfect a great many of the pictures taken. Or a photograph may be perfect technically and still, owing to unnatural setting or to an unnatural position of the bird, have little scientific value. Indeed a large percentage of good bird photographs, instead of showing the real character of the bird, show only the bird's response to fear.

A perfect photograph shows at a glance what pages of text would fail to convey. Moreover, it shows it more accurately, and it conveys exactly the same impression to everyone. In fact, the value of a photograph can be measured by its degree of superiority over a written description. The percentage of perfect photographs obtained by even the most experienced bird photographer is always necessarily small.

The accompanying photographs have been selected from the author's entire collection. With the exception of the least bittern, the birds are devoid of fear and oblivious to the presence of the photographer.

A WATER CHICKEN AND ITS NEST

The Florida gallinule, water chicken, or mud hen is about the size of a bantam and has many henlike notes including a loud raucous cackle, quite startling when heard close at hand. The gallinule belongs to the same family as the rails, and although it has the typical long, slender toes without webs, it swims readily. It does not usually venture far from the shelter of the reeds, however, and at the slightest alarm it patters across the water for cover. Its large, spotted, coffee-colored eggs are laid in a shallow nest of dried flags. If the water in the marsh rises, the nests are often built up a foot or more to keep the eggs dry



Wood pewee, a bird of the orchards and shade trees.—The mother bird is standing composedly by her nest on a dead branch after having fed her one remaining youngster. The nest is a shallow structure ornamented with bits of lichen, a concealing device employed also by the humming birds and gnat catchers

Yellow-breasted chat, a strange warbler.—This is the wariest, most timid, and therefore the most difficult to photograph of all our birds. During the breeding season it is often seen to spring from the top of a tree and, with dangling legs, jerking tail, and wings that seem disjointed, to flop through the air like a bird wounded and striving to reach the adjacent tree before falling to the ground. Its notes resemble everything from the clear whistle of a boy calling his dog, to the cry of a startled feline, or the chugging of a motor cycle climbing a hill

Smallest of our birds, the ruby-throated humming bird.—Here is a glimpse of the humming bird's home life. The young birds have their mouths open and are about to be fed with the nectar and minute insects that the mother bird has brought back in her crop. In feeding she inserts her bill far down into the throat of the young bird and injects the food into its crop. This particular nest, with its concealing lichens, is saddled on the branch of a pitch pine, a rather unusual site

A SECRET IN THE CAT-TAILS, THE HOME OF THE MARSH HAWK

To portray character is the ambition of an artist, but here the camera has caught the wild, fierce nature of the hawk just as the bird has alighted upon its nest and glanced about to see if all is well. The marsh hawk is a bird of open fields, shores, and marshes, and seldom alights in trees. It feeds mostly upon mice and frogs but sometimes takes birds. Its face is somewhat owl-like, owing to its large, though concealed, ears and, as with the owls, hearing probably plays an important part in the bird's pursuit of mice as they dart about in the long grass

SPRINGTIME SPARROWS THE SONG AND WHITE-THROATED

Birds and flowers are always associated, and with the blooming of the saxifrage and hepaticas come the song sparrows and whitethroats. The restlessness of the song sparrow and the composure of the whitethroat, so characteristic of each species, are here depicted as the two birds meet at the feeding station among the wild flowers. Feeding wild birds has become almost a pastime in many places. It saves the lives of many birds in times of stress, it gives much pleasure to those who can watch the feeding stations, it gives profit to the neighboring gardeners—and it makes unlimited opportunities for the bird photographer. It is in winter that food is most needed by the birds, but it is appreciated all through the spring and even in summer

AN EMBLEM OF PEACE, THE MOURNING DOVE

The camera has here caught a mourning dove in a pose true to its nature. Since the extermination of the passenger pigeon, this has been the only species of wild pigeon found in northeastern North America. Doves are poor nest builders and their crude platforms of sticks are often dislodged by storms. They usually select a stable site, however, and this nest, wedged against the trunk of a willow about fifteen feet from the ground, is quite secure. The soft cooing notes of the mourning dove are familiar sounds about orchards but they are not enjoyed by superstitious persons or others given to pessimism

RESTING GREEN HERON AND CONCEALING POSE OF LEAST BITTERN

Judging from this photograph, one could never guess the anatomy of the heron tribe. The long slender neck, so useful in spearing fish, is folded back on the shoulders and entirely concealed by the long feathers. The long legs also are partly concealed, and were it not for the long sharp bill and the short tail, one might suppose it to be a bird of ordinary shape.

Herons of all species while immature are either trustful or stupid and allow a close approach especially in a boat, but the adults are notably wary and thus are difficult subjects to photograph

The poses assumed by some birds when alarmed are quite suggestive of mimicry, seen most commonly among insects and rare in higher forms of life. This least bittern, normally shaped somewhat like the green heron, has stretched up its neck, pointed its bill upward, and drawn the feathers of the foreneck to a point, so that it simulates a broken reed or cat-tail and might be passed unnoticed. Indeed the writer, upon discovering the nest, actually counted the eggs before he noticed the bird perched in this position on the back of the nest

A WATER BABY'S FIRST SWIM

The young pied-billed grebe, just out of the egg, has struggled from the nest and the anxious mother is watching its first efforts at swimming. The pied-billed grebe, "water witch," or "hell-diver," is one of the most interesting birds of our ponds and marshes. It builds a floating nest of débris, anchoring it to the rushes, and when alarmed, quickly covers its eggs and dives from sight. Formerly this led to the belief that the grebes did not incubate their eggs as do other birds. The young birds have a striped pattern of black and white. The protective value of this is illustrated in the young bird crouching at the front of the nest. The young birds frequently climb on the back of the mother, and when there is any cause for alarm, she covers them with her wings and dives from sight

A water sprite, the Louisiana water thrush.—This is a bird of ravines and cascades. Ever tilting its body as though it had difficulty in balancing on its slender legs, it runs lightly over the wet stones. This photograph shows it resting for a moment in midstream, its bill full of black fly larvæ picked from the rocks in the swift current. Its young are near in a nest on a moss-covered ledge overhung with roots and ferns

A rocky cradle.—The killdeer builds no nest but merely scratches a hollow in the ground. The young killdeers do not need a soft nest because they are able to run about as soon as they hatch from the eggs. The killdeer formerly was shot as a game bird but it is now grouped with other migratory, insectivorous birds and given the protection that it deserves. Killdeers frequent fields, shores, and ploughed ground, sometimes far from water, and feed upon locusts, cutworms, and other insect pests

Thin as a rail.—The proverbial rail was more likely a fence than a bird, but thinness is quite as characteristic of these strange birds of the marshes. The body is compressed like that of a flea, to enable it to slip through the dense vegetation. Here a Virginia rail is sneaking to its nest

THE MEADOW LARK, A BIRD OF THE FIELDS

The meadow lark is ever alert and watchful, wary yet not timid. It is here shown perched on a rock in the grass near its nest. From the flirt of the tail to the glint in the eye, it is a wild, free meadow lark, unabashed by the presence of the concealed camera. In its bill are some insects for its young. Indeed the meadow lark is one of our most valuable, as well as most striking birds, consuming with great avidity grasshoppers, cutworms, army worms, white grubs, and other destructive pests of the field and garden. It is found in open fields throughout the eastern United States, and its clear plaintive whistle of several notes is one of the sweetest sounds of spring. In the West it is replaced by a very similar species, whose song, however, is quite different

SHEATHBILLS ON THE COAST OF SOUTH AMERICA

The sheathbills or kelp pigeons are allied to the shore birds, coming up in the fall from islands hundreds of miles south of Cape Horn where they nest, and spending the winter months along the beaches of South America. The crews of sailing vessels when passing through the Strait of Le Maire between Tierra del Fuego and Staten islands in the winter often see the birds flying out from shore to circle about their ships

Narrative of a Bird Quest in the Vicinity of Cape Horn[1]

By ROLLO H. BECK

ON THE twenty-eighth of December, 1914, we hoisted anchor at five thirty o'clock in the morning and started south from Hermite Island for the Horn. Before an hour had passed fog was pouring over Hermite Island, and the wind increased to a strong breeze. We headed in behind Jerdin Island and dropped anchor once more. The wind died down in the evening, and on the twenty-ninth we turned out again at five o'clock and got under way. A light northeast wind carried us down to Horn Island, and we rounded the Horn in flying style as the wind freshened on nearing the cape. Being in a small boat and the wind off shore, we passed close along the southern side of the island, taking photographs of the cape from different angles and, although at times sailing with the rail under water in the sudden fierce gusts that swooped down off the high cliffs of the promontory, we enjoyed to the full this pleasant passage of the Horn—a trip I had many years longed to make. Shearwaters and albatrosses swung high and low around us, and the rapacious skuas hurried from one flock of fishing birds to another in search of food, while the timber-strewn beach reminded us that the stories of wrecks credited to this point were not all fables.

We sailed to the southward about ten miles, but the breeze freshening, we turned back, and by the time Herschel Island was gained a heavy wind hurried us up the South Sea Pass to an anchorage at the southernmost point of Wollaston Island. We were held at Wollaston Island a week by prolonged gales, but found much of interest there, discovering and photographing sooty shearwaters' nests being the most important work. Near the top of a rocky ridge I found my first nest of this shearwater, and glancing up as I reached it, saw Cape Horn looming over Herschel Island just below me. When I thought of the thousands of sooty shearwaters I had seen about the islands of southern Alaska, and the hundreds of thousands in Monterey Bay, California, it seemed as if I had made a long journey before I finally laid my hands on my first nest within sight of Cape Horn. For ferocity in nesting birds I have yet to see the

When making long voyages the sextant is one of the instruments used by the navigator to determine his position. The above scene suggests to the initiated that eight bells soon will be struck and the man at the wheel relieved

[1] Conclusion of article begun in the January JOURNAL. Article and illustrations copyrighted, 1918, by Rollo H. Beck

A steamer trip through Beagle Channel or Smyth's Channel in winter is most interesting. The snow-covered islands with narrow channels between are always presenting new views of surpassing beauty, and although the fog may hang low for a time, one always has the hope that the next turn of the channel will reveal sunshine ahead

At Bertrand Island which lies only fifty miles north of Cape Horn, a few hundred sheep are raised yearly. The owner transports the surplus animals in his schooner "Antarctica" to Ushuaia, a small town in Tierra del Fuego, and his sailors are shown here passing a cargo from the lighter to the hands on board. The high price of wool and mutton makes the business a profitable one at present

equal of the sooty shearwaters. They scratched and screamed and were utterly unmanageable, absolutely refusing to remain in any position in the nest where their heads would show. After several birds were tried, I finally took one photograph with the bird ramming her head far up in a crack in the after part of the nest. Alaskan scenes were brought back to memory here also when I unexpectedly flushed a large seed snipe from the top of a rock-crowned ridge. The actions and color of the bird were so

like those of the crouching white-tailed ptarmigan that squatted by lichen-marked rocks on the rocky peaks about Seward, Alaska, that I wondered at the resemblance. I spent much time trying to obtain specimens and did find a brood of young, but the old birds eluded me until later.

The adaptability of the beeches, the principal tree of the southern forests, was shown here also. One could find within thirty yards trees from thirty feet or more tall down to creeping ones that could not exist if they raised their branches six inches above the granite rocks over which they crept. It was merely a question of location. One could walk along under the trees below a ridge, but as he began to get up where the wind from the west swept across, the branches suddenly multiplied and in some places were so thick that it was not difficult to walk along on top of the growth. When one got a little higher, however, where the unrestricted lash of the wind was felt, the branches dropped down into vinelike runners, and crept along for yards over the face of the granite rocks and boulders which littered the mountain-sides. Here also we saw burrows of the sea otter and the well-worn trails leading from the water up to them. Although we had seen many shells of the delicious centolla crabs at rocky points where otters had been feasting, not an animal did we encounter. We enjoyed on several occasions the excellent mussels which occur in such abundance in this region, and which in winter probably form the principal diet of the Indians. Centolla crabs we preferred to lobsters, which had been fed to us in abundance on Juan Fernandez Island the year be-

Fewer than a hundred of the fast disappearing Yahgan Indians of southern South America now remain, and the absence of children about their settlement at Rio Douglas, Navarin Island, is the most noticeable feature to the traveler who has seen the abundance of children about other Indian villages

CROWDED QUARTERS ON SHIPBOARD

The bird student who makes a specialty of collecting large birds often finds himself hampered by lack of room. While a dozen sparrows might be prepared on his lap or on a small box, a dozen geese require more space. The hold of a ship and a large packing case prove ideal. The presence of one hundred sheep also in the hold is not necessarily detrimental to the work, especially in winter when the temperature drops below zero

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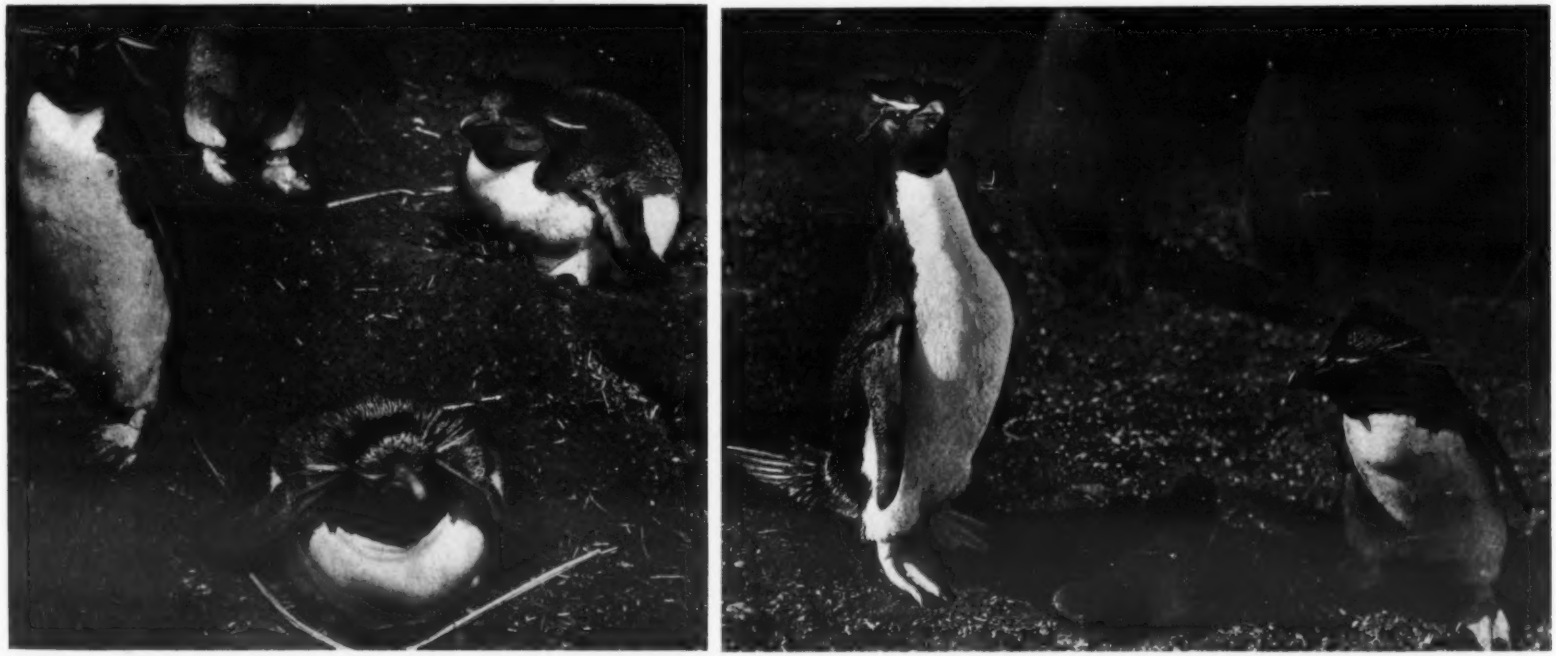


ROCK HOPPER PENGUINS

At the left, two rock hoppers on their nests, with their mates standing close by; at the right, parent rock hoppers, their helpless offspring between them.—The nest of this species is merely a depression in the ground, sometimes with a few grasses for lining. The rock hopper is an odd-looking fellow, clothed in slate-gray and white, with a bright red bill and erectile head plumes of sulphur-yellow. Like all penguins he is very sensitive to light. Note that three of the birds in the photograph have their eyes partly closed because of the brilliancy of the sunshine

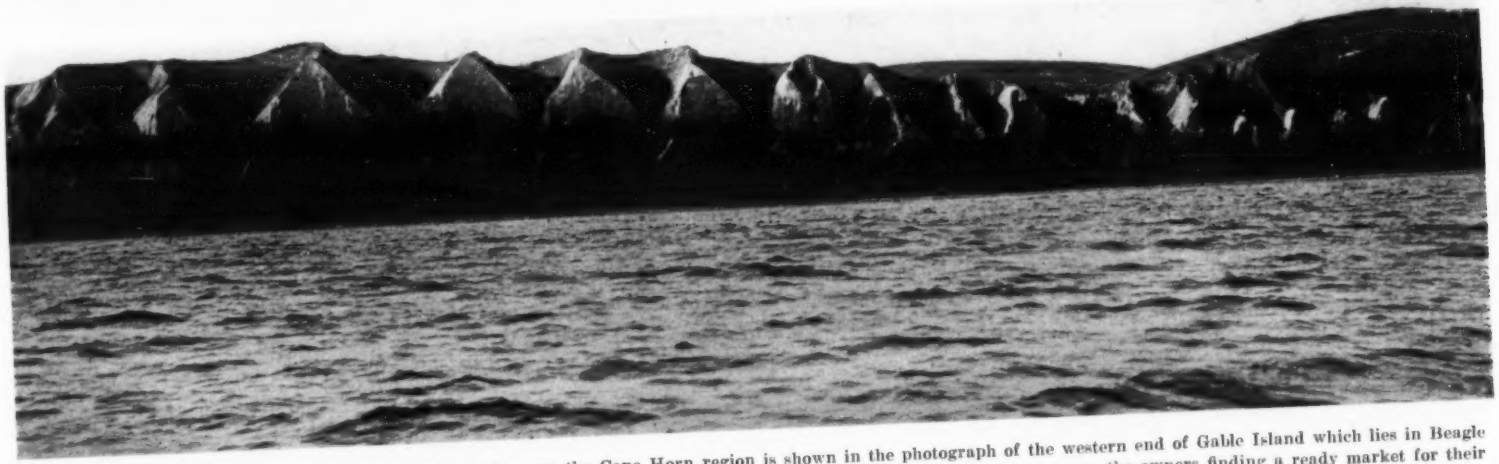
fore. The sailors caught very few fish for some reason, but the mussels and crabs and a couple of young fur seals which the captain palmed off on us as canned mutton proved very welcome additions to our larder. We used the wild celery in soup, and the Italian polenta, made of cornmeal and chopped duck and plovers, prepared by our captain, who sometimes took charge of the culinary operations, was excellent.

The wind subsided somewhat on the fifth of January, and we sailed around to the northern side of Wollaston, proceeding the next day to Bertrand Island, on which is probably the most southern sheep ranch in the world. A few years ago some sheep were kept for a while on Wollaston Island, but the Indians gradually killed them off. Bertrand Island is owned by Captain Grande, with whom I sailed a couple of times around Tierra del Fuego Island. His family being at the ranch when we arrived, we were treated to a piano recital by the daughter and tea and cakes by the *señora,* which brought us quite within civilization again.

We spent the next night anchored at Rio Douglas Mission, where the Yahgan Indian is making his last stand against extinction. It seems to be a losing fight, for the kindly, conscientious missionary, Mr. Williams, who had been in the country many years, told us not more than eighty remained of the hundreds that roamed the straits thirty years ago. When we visited them, only a dozen were about the encampment and, although there were at least four women to be seen, only a single child was noted, a babe in arms. The colony differed in this respect from the Indians of other localities visited, where as a rule one found from four upward to be the average number of children to each woman. Although Darwin, on his memorable voyage in the "Beagle," decided that this was one of the most degraded of human tribes, we found some of these Indians at least able to understand and speak a little English and Spanish besides their own language. Two of the men were working in the garden adjoining their huts, but the others seemed to have no pressing labor on hand. Several of them, however, the next morning gave us a hand in towing our boat out of the river against the tide, and we passed northward through the Murray Narrows to the Beagle Channel and headed back toward Punta Arenas. Our progress was somewhat slower going westward, as the winds usually blew from that direction. For forty miles the channel nowhere exceeds four miles in width, and it narrows down to less than a mile at one spot. The mountains close to the channel run up three thousand feet or so, although French Peak, seven or eight miles back on the Tierra del Fuego side, stretches up more than seven thousand feet. Several glaciers crawl down and drop their ice into the cold waters of the channel, and the trip through this part of the archipelago is one of exceeding interest.

One morning, just after passing the most picturesque part of the journey, we saw smoke curling up from behind a point of land near us, and on investigation discovered an old Indian and his squaw camped on the gravelly beach, preparing to enjoy a repast of boiled young shags. The manner of cooking the birds was most simple: they were grasped by the neck in the same condition as when taken from the nest and deposited in a kerosene can half full of boiling water. As the lower bird in the can became cooked it was hauled out with a stick, and an uncooked bird pushed down in its place. A small cat and three dogs accompanied the Indians, who later came paddling past our boat in their little dugout canoe with dogs, cat, fire, and food distributed promiscuously from stem to stern.

Although we had started westward in Beagle Channel on the eighth, the head wind and bad weather retarded us to such an extent that Brecknock Pass, about a hundred and fifty miles from Murray Narrows, was not reached until



One of the striking effects of the heavy gales that sweep the Cape Horn region is shown in the photograph of the western end of Gable Island which lies in Beagle Channel and thus is fully exposed to the prevailing winds. Gable Island has been used for a sheep range for many years, the owners finding a ready market for their mutton at Ushuaia, the Argentine penal settlement a few miles away

The most southern ranch house in the world is situated on Bertrand Island, Chile, about fifty miles north of Cape Horn. The house can be seen at the right-hand side of the photograph, and the schooner "Antarctica" which, with the island, belongs to Captain Oreste Grande, is shown on the left. Navarin Island, in the background, is the home of hundreds of guanacos. Many are killed in winter when they are forced down to the seashore by heavy snowfall in the interior

The higher peaks of the southern islands are seldom seen, being usually hidden by enveloping clouds, but when the veil is lifted for a short time, one gets views of cold precipitous cliffs, as was the case when the above photograph was taken

Ushuaia is situated on the south side of Tierra del Fuego Island, and contains a large prison in which are confined the worst criminals of Argentina. The prison, which is modeled after a Philadelphia one, contained about eight hundred prisoners in 1915, and was still unfinished. A small steamer makes frequent trips from Punta Arenas, and a monthly trip is made from Buenos Aires. A small wireless station keeps the inhabitants posted on the happenings to the northward of them

the nineteenth. As we reached the pass the squalls increased, and we had to run in and anchor. Rain, hail, or snow would sweep over the island in a sudden squall, after which, perhaps, the sun would shine for a few minutes and then be blotted out by another squall. While awaiting fairer weather, I climbed up to the top of Brecknock Island and obtained several of the large seed snipe first seen on Wollaston Island. On a nest with four eggs, by the side of a small rock, a sitting bird was wholly exposed to the beating hail squalls. One of these passed over just before I reached the nest, the cutting pellets driving with such force that I could not face them. A couple of broods of half-grown young were seen running about among the rocks, but they were as invisible as young terns on a gravelly beach the moment they squatted down to hide.

Heavy seas and squalls drove us back three times when we essayed to weather the point into the open Cockburn Channel, and the third time we drifted on to a sunken rock when edging in to anchor. Although we ran out the kedge anchor, it was not until a substantial rise in the tide assisted us that we finally slid off our precarious perch. The fourth trial was successful and we ran out into Cockburn Channel at five o'clock on the morning of January 22. Heading northward before a fair south wind, we made the ninety miles to Punta Arenas by seven o'clock in the evening, thus finishing a most interesting two months' trip in a locality where, unless one is provided with experienced help, he is very likely to be reported missing, as were the two youths we met during our short cruise.

Although the trip had been well worth while, and a most interesting lot of material had been gathered, I had not obtained the yellow-nosed albatross, one of the most desirable birds of the southern ocean. Meeting Captain Grande, who was carrying firewood from Beagle Channel to Rio Gallegos, about forty miles north of Magellan Strait, I bargained with him to run out to Diego Ramirez Island with me after he had discharged a small cargo at Ushuaia, the Argentine penal settlement just across Beagle Channel from Murray Narrows. It was two months before we got away from Punta Arenas and it was April 7 before we reached Lort Bay again, having had to turn back on account of bad weather after getting a few miles outside of False Cape Horn. Diego Ramirez is similar to Ildefonso Island inasmuch as only a fair weather landing can be made. We remained at Lort Bay until April 20, having both anchors down most of the time, and howling gales with heavy snowfalls to prevent our leaving. As we had expected to return to Bertrand Island about April 10, we had taken only a couple of sheep and a guanaco to eat and these had been consumed by the twentieth. Therefore when clear weather showed on that date we sailed back to the captain's ranch and I decided, as the birds probably had left the nesting ground by this time, to take a chance on finding them off the south side of Tierra del Fuego as we sailed out of Beagle Channel. We took a load of sheep from Bertrand Island for Ushuaia and left Beagle Channel with a load of firewood for Rio Gallegos on May 6, but although wandering and black-browed albatrosses were seen, none of the yellow-nosed were sighted, nor were any seen on the run up the coast.

As winter time was near at hand and there was a probability of some of the pelagic Antarctic birds coming up along the Tierra del Fuego coast, I made a second trip around this island with Captain Grande, and in September hired his vessel for a run out to sea around the Falkland Islands down to Staten Island and back to Magellan Strait. In all these months I never once saw an unmistakable yellow-nosed albatross and finally gave up the quest as the summer time drew near.

A MIOCENE WATER HOLE

Preliminary sketch by Erwin Christman for a group of fossil skeletons from the great Agate Quarry in western Nebraska, to be placed in the center of the Tertiary mammal hall of the Museum. Four skeletons of *Moropus* are included in the group, one of which has been completed. The other five animals in the foreground are the giant pig, *Dinohyus* (right), and dwarf rhinoceroses, *Diceratherium* (center). The remains of these three animals are found in the quarry in great abundance and finely preserved. It was perhaps an ancient water hole where these animals came to drink and were caught in a quicksand bottom

The Mounted Skeleton of *Moropus* in the American Museum

A "CLAWED UNGULATE" FROM THE MIDDLE TERTIARY OF NEBRASKA

By W. D. MATTHEW

MOROPUS is a big extinct animal that lived in North America. It was one of the oddest looking beasts of its time, a combination of horse, rhinoceros, and camel or giraffe in its general appearance, but with enormous claws on the front feet and smaller claws on the hind feet, utterly unlike the hoofs of the ordinary ungulates or "hoofed mammals."

All of the large herbivorous animals today and nearly all of the extinct kinds have hoofs on the feet. They have no need for claws. The feet are used to carry them about, but not for attacking other animals or for tearing their prey or for digging, as in the clawed animals. This is so general a rule that it was long thought to be universal, a law of nature, and it was, in fact, included in the Law of Correlation expounded by the famous naturalist, Cuvier, a century ago. Horns and hoofs he declared were the exclusive prerogative of vegetarian animals. If the horns were in pairs, so too were the hoofs. Conversely, claws pertained to carnivorous animals for the most part, while no carnivorous animal had hoofs.

They tell a story about Cuvier to illustrate his confidence in this "Law of Correlation." It seems that one of his students, who desired to give the *Maître* a scare, disguised himself as the Devil, with the usual horns and hoofs and barb-tipped tail. He penetrated at midnight to Cuvier's room and, standing by his bedside, roused him from sleep with the announcement, "Cuvier, Cuvier, wake up! I am the Devil and am come to eat you up." The scientist gazed at him sleepily, looked him over for a moment, and replied, "Hmm—horns—hoofs—you're graminivorous. You can't do it." Whereupon he turned over and went to sleep again and the student retired discomfited.

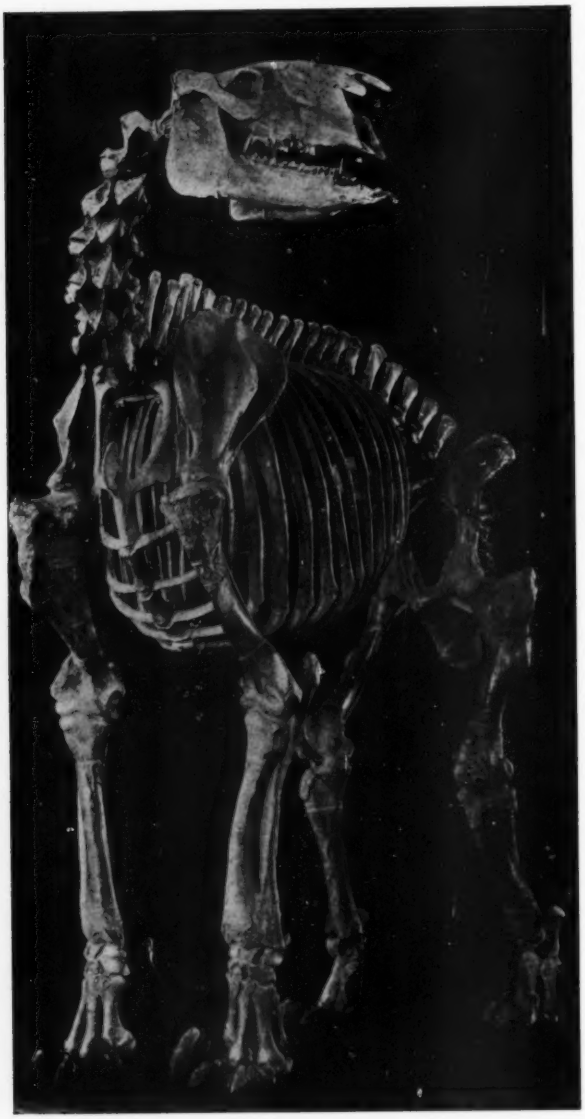
But for all Cuvier's faith in his Law of Correlation, there are some exceptions, and our *Moropus* is one of them. Many years ago, when the first scattered bones of this animal and its fossil relatives in Europe were discovered, the teeth and skull parts were described as related to the rhinoceroses and the extinct palæotheres and titanotheres, all of them belonging to the Perissodactyl order of ungulates which includes also the horse and the tapir. The claws and other footbones were supposed to belong to an entirely different animal related to the anteaters. Cuvier himself described one of the great claws as a "pangolin gigantesque"—a gigantic anteater. It was many years before it was found that these skulls and these footbones belonged to the same animal. No complete skeletons have yet been found in the Old World.

In this country a few scattered bones of *Moropus* had been found thirty or forty years ago, but it was not until the discovery of the great Agate Spring Fossil Quarry in western Nebraska that much was known about the animal. This quarry was first discovered by Mr. James H. Cook, of Agate, Nebraska, and was opened up and worked on a large scale by the Carnegie Museum of Pittsburgh between 1904 and 1908.[1]

[1] They obtained a great series of skeletons of the little pair horned rhinoceros, *Diceratherium*, a skeleton of the giant pig, *Dinohyus*, and a number of incomplete skeletons of the *Moropus* from which a mount was reconstructed.

...sauce and finely preserved. It was perhaps an ancient water hole where these animals came to drink and were caught in a quicksand bottom
120

The American Museum has had parties working in this quarry for several years past, and has been especially fortunate in obtaining a whole series of more or less complete and finely preserved skeletons of the *Moropus,* besides quantities of other material. There are no fewer than seventeen skeletons, each being the bones of one individual, and the best of them are virtually complete.



Skeleton of *Moropus,* found in the great Agate Spring Fossil Quarry, western Nebraska, and recently placed on exhibition in the Tertiary mammal hall of the American Museum. Note the large claws on the fore feet although it belongs to the ungulates or hoofed animals. The big extinct *Moropus* was one of the oddest looking beasts of its time, a combination of horse, rhinoceros, and camel or giraffe in its general appearance, but as seen here, with enormous claws on the front feet and smaller claws on the hind feet. American Museum parties working in this quarry for several years past have been unusually fortunate in obtaining a large series of *Moropus* skeletons, no fewer than seventeen representing the bones of as many single individuals, and the best of them virtually complete

The task of extracting and preparing these thousands of fragile and delicate bones has been a long and difficult one, and it is only now that we have been able to place the first skeleton of *Moropus* on exhibition.[1] This is mounted in a standing position, the pose adopted representing the animal as looking off into the distance (toward the visitor as he enters the hall). Other skeletons, of both male and female animals, will be added later to form a group.

The *Moropus* was a relative—albeit a distant one—of the rhinoceroses, tapirs, and horses, and belongs with them in the order of Perissodactyls, hoofed animals with an odd number of toes on the hind foot. The ruminants,

[1] The field work and preparation of the specimens have been in charge of Mr. Albert Thomson of the Museum staff. The skeleton was mounted by Mr. Charles Lang. The technical skill, carefulness, and scientific accuracy through all stages of the work make this skeleton one of the finest examples of modern methods of dealing with fossil vertebrates. The visitor with a little constructive imagination can readily see in the skeleton the proportions and pose of the animal; and it is as accurately true to life as the most careful scientific study can bring about.

camels, pigs, and hippopotamuses have an even number of toes—either two or four. *Moropus* has three, like a rhinoceros or tapir. It is about the size of a rhinoceros, but very different in proportions. The head and neck are proportioned more like those in the horse, the rounded back suggests the tapir, and the legs, while massive, are longer than in the rhino, especially the fore limbs. The feet with their great claws are entirely different, and more like those of anteaters and similar digging animals than any of the hoofed animals to which *Moropus* really belongs. The front teeth are like those of ruminants, while the grinding teeth are most like some of the extinct Perissodactyls—the palæothere of Europe and the titanothere of North America.

The teeth show that the animal was herbivorous, of browsing habits, and quite inoffensive. What use he made of his big claws is rather a puzzle. They could not have been of much value for fighting, for the foot and limb are too stiff and clumsy to be used except for ordinary locomotion. For the same reason they could be of only limited use in digging. The anteaters and armadillos use their great claws in digging out ant hills; the sloth uses his in hanging from trees; the bear finds his claws useful both in digging and fighting, while the cat family reserve their sharp claws strictly for fighting. But bears and cats have much more mobile limbs and feet, and it is certain that the *Moropus* did not live on ants or any such food, and could not possibly climb a tree, much less hang from one. The teeth show clearly that his food was leaves and herbage, and that he cropped it after the fashion of a deer or cow. He was not even omnivorous like the pig, which does a considerable amount of digging after succulent roots and tubers with his snout though not with his feet.

The only plausible suggestion that has been made is that the great claws were designed to aid the *Moropus* in scraping away sand in dry riverbeds or other suitable places to make a water hole where he might drink. There is good reason to believe that the western country where he lived was even then more or less arid, with a scanty water supply in the summer or seasons of drought. In Central Africa today the animals congregate in great numbers around the scattered water holes, and some of them may dig out the holes more or less with their paws. Our *Moropus* could do that sort of thing to great advantage, and the powerful claws often might enable him to dig down in a sandy riverbed to water that otherwise would be beyond his reach.

The modern moose and caribou use their long and rather narrow hoofs not only to support them on soft ground, but also to dig down through the snow and uncover food beneath it in the hungry winter season. But it is not likely that the Western Plains was a region of cold winters and deep snows in the time when the *Moropus* lived there. Rather was it like Central Africa today, at least in the summer season, although not having a tropical climate the year around.

Courtesy of the New York Zoölogical Society

SMALL-MOUTHED BLACK BASS WINTERING IN NEW YORK AQUARIUM

Although the various species of fresh water fishes react differently to cold, it is known that many can endure very low temperatures, even freezing. Certain species of the North like the Alaska blackfish have extraordinary vitality, and when thawed out after lying frozen for many months will prove as lively as ever. In winter at the New York Aquarium the water flowing through the tanks sometimes reaches a rather low mark. When it is below forty degrees Fahr., some of the fishes become sluggish and take little food. Young yellow perches remain on the bottom but the young black bass poise in water, fifty or more compactly bunched, mostly heading one way. For the game qualities of black bass see *Fishes*, by David Starr Jordan, Vol. II, pp. 301–304

Democracy and Science

Each man, each idea, each theory standing for what it is, with all the "garment of make-believe thrown off"

By DAVID STARR JORDAN

THE spirit of democracy favors the advance of science. Democracy seems at first to level, because it tears down all artificial props. All men start alike, and all ideas must struggle alike for existence. The tradition of a thousand years to a democracy, is, to borrow Huxley's phrase, "but as the hearsay of yesterday." And this should be true of all tradition in the face of truth. A truth is valued for what it is—nothing more. In a democracy truth stands on its own feet, as a man ought to, and opinion may be assailed from any side. Tradition does not help it, and there is no weight in authority. Democracy at last brings each one to his own. It is not a leveler. It is the great unequalizer, the power which makes each man equal to his own fate, regardless of the fate of all other men. And as no two men deserve the same in life, fair play must end in final inequality.

In the fields of Science, it is easy to notice the influence of political conditions on the individual point of view. The American worker applies his rules regardless of whether they affect great men or small. He knows no tradition large enough to check the movement of knowledge. Among the Scandinavians and the Dutch, in nations too small to obscure the democracy of learning, we find much the same feeling. In Germany, in France, even in England, the tradition of great names, the customs of great institutions, largely outweigh the testimony of things themselves. There is always a reserve of exceptions in favor of great men or the traditions of great institutions. The willingness to adopt new views, to utilize new classifications, to see things in new lights, is, broadly speaking, in proportion to the spirit of democracy by which a worker is surrounded. A perfect democracy means a perfect intellectual perspective—each man, each idea, each theory standing for what it is, with all the "garment of make-believe thrown off."

MAIDENHAIR GROWING ON THE PERPENDICULAR SIDE OF A LIME SINK

The shady or southern side of lime sinks often harbors such a luxuriant growth of this graceful fern that the eroded rock wall is completely hidden by drooping masses of brilliant leaves, giving the appearance of a green water fall. This plant grows as well on the horizontal hammock floor, concealing from view the numerous little well-like sinks. It thus makes walking in the hammocks dangerous. Scattered among the maidenhair may be seen a few leaves of the halberd fern, and in the shadow in the left-hand corner are a few leaves of the creeping wood fern. On the hammock floor, about the edge of the sink, is a plant of the strap fern with erect leaves, and to its right a cluster of leaves of the sword fern

Only after a rainfall does the resurrection fern expand its leaves and become green and as conspicuous as it appears on the prostrate log in the foreground. At other times the numerous leaves are curled up and shriveled, exposing only gray, scaly, lower surfaces, and the plant appears as a dead mass attached to the trunks of trees or lying on the branches. The spore cases are set in pocket-like depressions on the lower side of the leaf blade, thus helping to retain the spores during alternate expanding and shrinking of the leaves.

In the moist soil of the bottom of the sink are several plants of the leather fern. These remain fresh and green throughout the year, and sometimes attain a height of ten feet. The numerous spores and spore cases completely cover the lower surface of some of the leaflets with a red or brown feltlike coating

Ferns of Tropical Florida[1]

By JOHN KUNKEL SMALL

Head Curator of the Museum and Herbarium of the New York Botanical Garden

THE fern flora of tropical Florida is exceedingly rich. The number of ferns and fern allies in this region is quite remarkable when we consider that the area involved comprises only a few hundred square miles, a mere fraction of the state's large area. Although variety in soil and other physical features is slight, this area harbors more than fifty per cent of the fern flora of Florida. An overwhelming majority of the species are typically tropical American. In addition to these, there are several cosmopolitan and a few endemic ferns. Nearly one third of the species are epiphytic, living on the moisture of the air only, while anchored on trees or on prostrate logs. This condition doubtless makes up to some extent for the lack of variety in topography, climate, and soil.

Tropical Florida, as here understood, consists of two definite areas composed

[1] Written as preface for a new handbook on the ferns and fern allies of tropical Florida, now in preparation by Dr. Small. The illustrations are from photographs by the Author

BED OF BOSTON FERN IN AN EVERGLADE HAMMOCK

Sometimes occurring in impenetrable masses so dense that the tangle of living and dead leaves is firm enough to support a man walking three or four feet above the hammock floor, the vinelike leaves of the Boston fern clamber over shrubs and up the trunks of trees, and hang over the branches. For length of leaf this fern holds the record. In a few favorable localities leaves more than eighteen feet long are not uncommon. The longest leaf on record recently measured was twenty-seven feet, two inches. A few scattered plants of the sword fern are shown here mingled with the Boston fern. Both are terrestrial and very common in the high pineland and Everglade hammocks; the sword fern is also epiphytic, growing on trunks and branches of various hardwood trees and thriving luxuriantly among the old leaf bases just under the crown of leaves on the cabbage palmetto. The sword fern is especially abundant in the Lake Okeechobee region

of limestone and of coral rock. The one area comprises the Everglade Keys[1] (limestone), which are situated in the southeastern part of the Everglades; the other, the Florida Keys (coral rock and limestone), which are situated in the tropical sea. Although outside the bounds of the torrid zone, their vegetation, like that of their neighbors, the greater number of the Bahama Islands, is predominantly tropical.

The Everglade Keys consist of two main divisions, the Biscayne pineland[2] and the Long Key pineland. The former group is made up of about a dozen larger islands, which are mostly bounded by the Everglades on two sides and separated from one another by narrow channel-like intersecting prairies. The Long Key group has a much smaller area than the Biscayne pineland. It consists of about five larger islands and a few smaller ones. Both groups are of limestone, and they are slightly elevated above the Everglades. The rock is rather porous, and the softer spots of the almost universally exposed surface have been eroded mostly by leaching out, so as to form a surface honeycombed with all sizes of cavities having very ragged and sharp edges. These limestone islands are almost completely forested with the Caribbean pine (*Pinus caribæa*) which grows nearly everywhere on the exposed rock. However, the pine woods, or pinelands, are interrupted here and there by hammocks[3] or areas of hardwood shrubs and trees, some areas small and some much larger, although all taken together these comprise but a very small percentage of the region under consideration. The hammocks may be divided into two groups: First, the high pineland hammocks which are islands, so to speak, of hardwood trees in the pine woods. They are dry except for the water contained in deep lime sinks and in the humid air. They number about a score. Second, are the low pineland hammocks, indefinite in number and situated along the boundary line of the pinelands and the Everglades proper and prairies. These are usually high and dry toward the pine woods and low and wet along the Everglades or prairies.

The ratio of pineland ferns to hammock ferns seems astonishingly small. Only two kinds of ferns are naturally pineland plants. Even these two ferns will spring up in clearings in hammocks which have been partly destroyed either by nature or by man. The other fifty species of ferns are hammock plants! Their habit ranges from the stiffest to the most graceful, and their structure from the coarsest to the most delicate. The pineland species are strictly terrestrial in habit. The hammock kinds are to a great extent epiphytic.

The hammocks of the Biscayne pineland are rich repositories of ferns. Nearly all the kinds of ferns of tropical Florida may be found in them. The well-like lime sinks, the hammock floor, and the trunks and limbs of rough-barked trees are the habitats of the many species, and each and all form ferneries of indescribable beauty. They can be appreciated by the eye alone, even the camera falls far short of doing them justice. In some places the deep

[1] The word "key" (Spanish *cayo*, British *cay*), primarily applied to islands along the coast in and near Spanish speaking countries, largely replaces the use of the word "island" in southern Florida, and by the inhabitants is applied to islands in the Everglades as well as to the islands of the coasts and reef of Florida.

[2] These two groups of islands are separated from each other by a distance of three miles. The intervening Everglades contain a number of sloughs which represent the upper reaches of an unmapped river that flows southward and empties into the Bay of Florida. The larger or eastern group of islands takes its name from Bay Biscayne which washes the shores of one of the islands for a distance of about fifteen miles. The smaller group takes its name from Long Key, the largest island lying west of the sloughs referred to above.

[3] A hammock—the word probably of Indian origin—is a dense growth of mostly broad-leaved shrubs and trees, thus giving shade, in a pine forest or on a prairie. The use of the word is confined especially to Florida and adjacent states. It was formerly confused with the word hummock.

HIGH PINELAND HAMMOCK ON THE EVERGLADE KEYS

The strap fern (in the foreground) often produces tufts of leaves reaching as high as a man's head. This fern grows equally well in the humus of the hammock floor and on trunks and limbs of trees, throughout the southern half of the Florida peninsula as well as in nearly all parts of tropical America. It is more common on the Everglade Keys, although it grows sparingly on most of the larger islands of the Florida reef.

Sword fern and Boston fern may be seen growing among the plants of the strap fern. Back of the ferns is a dense jungle in which several kinds of air plants, both bromeliads and orchids, are growing on the tree trunks

bromeliads and orchids, are growing on the tree trunks

A PITFALL IN THE FLOOR OF A HAMMOCK

This mass of leaves of the halberd fern hides a lime sink, the stems of most of the leaves being wholly within the well-like hole underneath. The broad leaves grow from a foot to a foot and a half long; sometimes they are merely lobed, or they may be parted, or compound, and the divisions again lobed.

Scattered leaves of the sword fern and maidenhair may be seen, and four long narrow leaves of the strap fern are shown rising near the center of the mass

sinks have their sides completely covered with mats of iridescent filmy ferns to the exclusion of all other vegetation, while adjacent tree trunks and logs are completely covered with another kind of filmy fern. The filmy fern is common in tropical America. It was not discovered in Florida until 1901. Some species are found in dense hammocks, growing on trees and shrubs both near the ground and high up, often covering trunks and limbs with masses that can be stripped off as mats several square feet in size. In other sinks the small halberd fern, the most abundant of the fern species, predominates, while in still others we find the honeycombed rock sides adorned with various ferns, filmies, maidenhair, halberd fern, wood fern, and spleenwort, not to mention the rarer holly fern.

The hammock floor is another kind of fernery. There the strap fern, various wood ferns, maidenhair, spleenworts, sword fern, and large halberd fern, comprise the most conspicuous kinds. One species of wood fern (*Dryopteris ampla*) is, at the same time, the most conspicuous and the most elegant. This is the largest of our shield ferns and grows in small lime sinks on the hammock floor. The erect rootstock is commonly raised a foot or a foot and a half above the surface of the ground, thus forming a trunk which supports a crown of beautifully arching lacelike leaves with a spread of twelve feet! Thus, in habit it is a tree fern. The large leaves separate readily from the rootstock, and in parting retain a dense tuft of brilliant red scales at the base of the petiole. Still other varieties of the shield fern prefer the hammock floor to the lime sinks, and in the dense jungle often grow very large. Leaves eight feet long with slender narrow leaflets are not unusual. A tangled mass of these large plants, covering from a square rod to a quarter of an acre, is a wonderful sight.

In these remarkable hammocks there are ferns everywhere—ferns underground, ferns on the ground, and ferns in the air. The trunks and limbs of rough-barked trees are actually clothed with masses of ferns, as well as with orchids and other air plants. The resurrection fern, the leaves of which shrivel and curl up in dry weather, but are restored to a perfectly fresh state by a rainstorm, the strap fern with its long narrow leaves, and the Boston fern, are the most common epiphytic kinds. The last mentioned has the distinction of having the longest leaves of any of our ferns, a length of eighteen feet being not uncommon, while the maximum length is twenty-seven feet and two inches. These long leaves often clamber like vines over shrubs and up tree trunks and hang over the limbs of trees. The climbing fern occurs plentifully in one hammock. Its stems and branches adhere closely to the stems of shrubs and trees, especially to the smooth-barked kinds. Occasionally it climbs up trees to the height of twenty-five feet. Palmetto trees are often conspicuous ferneries. Below the crown of leaves and growing from among the old leaf bases one often finds a collection of Boston fern, grass fern, hand fern, and serpent fern.

One rather extraneous area comes within our range, namely Royal Palm Hammock.[1] This is an Everglade hammock lying between the Biscayne pineland and the Long Key pineland. It has a low rock floor, which is covered with a foot or more of humus. Thus far it is not known to have any ferns that do not grow also in the hammocks of the rest of our area. There are about a dozen kinds of ferns common in its jungle.

The Florida Keys comprise two divisions of a chain of rock islands which are really situated in the waters of the

[1] Known also as Paradise Key. Now within a reservation with the official designation of Royal Palm State Park. See *Tropic Magazine*, 4: 5–16, 1916, and *Journal of the New York Botanical Garden*, 17: 165–172, 1916.

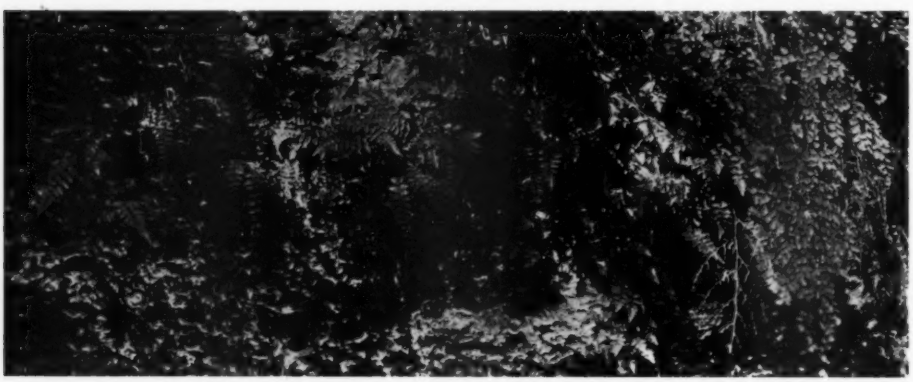
WOOD FERN OF TROPICAL AMERICA

The bed of which the picture shows a part, was several square rods in extent. Large areas of the floor in high pine-land hammocks are often covered by this fern, especially where the shade is not too dense. The more or less horizontal blades of the arching leaves are commonly so numerous that they completely hide the ground beneath them. The leaves do not take root at the tip; the fern reproduces itself only by the myriads of spores which are distributed from numerous small spore cases borne on the under side of the leaves

Gulf Stream. These are the Upper Florida Keys (coral) and the Lower Florida Keys (limestone). The Upper Keys are for the most part long and narrow ridges of coral rock and are clothed with hardwood forests which harbor two species of ferns not yet known to occur on the Everglade Keys. The Lower Keys are more spread out, and rather less elevated above the sea. They are clothed both with hardwood forests and, in the case of a half dozen islands, with pine woods at least in part. The Lower Keys have as yet disclosed no ferns not already known on the Everglade Keys. In fact, the Florida Keys have a much smaller fern flora than the Everglade Keys. Only about one fifth of the species of the Everglade Keys have been found there. No doubt in their past the fern flora was larger than it is now. It may have rivaled or excelled that of the Everglade Keys, for the Florida Keys consist of two areas of different ages, coral and limestone; but this region has been for a long time decidedly on the wane.

In addition to the leaching process of erosion that has reduced the surface of the Everglade Keys, the Florida Keys have had the mechanical and chemical action of the sea to contend with, and the evidences of reduction are not hard to observe. Compared with the Florida Keys the Everglade Keys have had a very peaceful existence. The latter have been sheltered by their inland position, while the Florida Keys have received the hard knocks. These islands not only have been worn down and washed away by the never ceasing action of the sea, but also by the hurricanes of ages. This is quite evident. The rock surface, particularly in the case of the Lower Keys whose limestone corresponds to that of the Everglade Keys, is polished off and platelike, instead of merely leached out and honeycombed. What the former fern flora consisted of we cannot even imagine, but we are safe in assuming that it was more extensive than that which we find there now.

About two score years ago a writer on ferns, judging from a few collections that had reached him from southern Florida, predicted that more tropical American ferns would be discovered in that region. Since the beginning of this century his prophecy has been fulfilled by the discovery of about a score and a half of ferns and fern allies before known only from insular and continental tropical America.



This creeping wood fern is a "walking fern." The long tips rest on the surface of the rock, take root, and form new plants, which in turn repeat the process. The fern is reproduced also by spores which are borne in round spore cases on the lower surface of the leaves. This colony of walking fern was found growing on the perpendicular walls of a lime sink in a high pineland hammock

On the Use of the Diving Helmet in Submarine Biological Work*

By E. W. GUDGER

Professor of Biology, State Normal College, Greensboro, North Carolina

IN a number of the *Bulletin of the New York Zoölogical Society* for 1916, Dr. Alfred G. Mayer[1] referred incidentally to the use of a diving helmet for work in submarine biology at the Tortugas, Florida, Marine Biological Laboratory of the Carnegie Institution of Washington, and gave a figure of such an apparatus in actual use. In accordance with Dr. Mayer's customary liberality in providing everything available for furthering the work at Tortugas, the use of such a hood there was inaugurated in the season of 1915. At that time this helmet was a new thing, and its utilization for the study and collection of marine organisms in their natural habitat was thought to be its first use for such a purpose in the history of science. However, such is not the case.

At Tortugas, during the season of 1915, Prof. W. H. Longley and Dr. Lewis R. Cary did considerable experimental work with this diving helmet. During the summers of 1916 and 1917 the helmet was in very frequent use, both these men becoming quite skilled in descending to moderate depths and in studying the fauna and flora there. By its use Professor Longley was enabled to go down on to the coral reef off Loggerhead Key and there, in Dr. Mayer's words, "to become a fish among the fishes," which he studied literally at arm's length. Thus equipped and thus located, he has made observations of the habits of reef fishes as valuable as they are interesting. Furthermore, wearing this helmet and using a camera contained in a specially devised watertight metallic box, Professor Longley has been able to take some remarkable submarine photographs of the fishes in the rocky recesses of the reef, their home. Especially valuable are these photographs in the study of the changeable color phases of the fishes when under the influence of various emotions, or when changing from one colored substratum to another, or when varying with the amount of light received.[2]

The diving helmet[3] is really an apparatus as simple as it is effective for use at moderate depths. It consists of a barrel-shaped brass hood with a conical top having a handhold or grip for putting it on or lifting it off the head of the diver. In front, corresponding in position with the face of the diver, is a plate glass window through which the wearer makes his observations. At the base of the hood are metal flaps descending a short distance over the breast and back of the wearer but cut away in the region of the shoulders to let the apparatus fit snugly and securely around the neck and on the shoulders. To the back flap, and if necessary to the front one also, may be attached masses of lead to overcome the buoyancy of the diver and to hold him firmly on the bottom. Fastened to the hood is a rubber hose extending to the attending boat at the surface where it is connected with a double-cylindered hand pump worked by a long lever so attached as to compress the air in each cylinder alternately. The respired air, together with the excess of air driven into the hood by the pump, escapes under the edge of the hood in a great stream of bubbles. The shallow and wonderfully clear water at Tortugas makes it possible for a man sitting in the boat and using a "water glass" (a bucket having a pane of glass set in the bottom) when the surface of the water is covered with ripples, to see easily what is going on below and hence to regulate readily the amount of air sent down for the use of the diver. Professor Longley found that about eighty pounds of "ballast" were necessary to steady him on the bottom in water from eighteen to twenty feet deep, and that he could easily remain down for thirty minutes in comparative comfort.

[1] Mayer, Alfred G., Longley's and Reighard's Studies of the Reef Fishes of the Tortugas, Florida. *Bulletin New York Zoölogical Society*, 1916, vol. 19, pp. 1335–1336. 1 fig.

[2] Longley, W. H., Studies upon the Biological Significance of Animal Coloration. *Journal of Experimental Zoölogy*, 1917, vol. 23, pp. 533–600. 1 pl.

[3] Invented by Mr. W. S. Dunn of Miami, Florida.

* Indebtedness is acknowledged to Mr. W. F. Miller, president of the Miller-Dunn Company, Miami, Florida, for the use of the illustrations in this article, as well as for valuable data.—E. W. G.

The writer conjectures that the idea resulting in the development and use of this diving hood probably originated in the following interesting way. The building of that wonderful over sea railroad, the Florida East Coast Railway Extension, from Homestead to Key West, called for the erection of miles and miles of concrete viaduct, most of it in relatively shallow water. In this work the services of many divers were in constant demand. The work of such men called for hours of service and for quickness of movement when in the water, as well as for quick ascent to the surface and ready removal of the armor, rather than for protection from a great weight of superincumbent water. To meet these exigencies of service, the regular scaphander or diving suit was in the main abandoned, the helmet only being retained. The gain in ease of work while in the water, in quick ascent to the surface, and in ready removal of the helmet when in the boat, at once will be perceived by any one who has watched the snail-like movements of an armor-encased diver, his slow ascent to the surface, and the slower process of removal of the helmet. Wearing the helmet only, a diver, in case of danger or of trouble in the matter of his air supply, needs but to lift off the helmet to be driven to the surface like a shot. I have myself seen a diver, working on the railway docks at Key West, sitting on the bottom in twenty feet of water calmly sawing off piles with a one-man crosscut saw. When tired, or when his work was done, he would climb a ladder to the surface, his helmet would be removed and he would sit down quietly until wanted again. Then in three minutes he would be at his post.

The use of the helmet alone of a diving suit probably is common in shallow and clear waters the world over, but its use in the United States seems to be restricted to the clear waters of Florida.[1]

The use of the scaphander or diving suit in submarine work dates back to about 1839. Its use in biological work apparently is limited and recent. Its use in the commercial collecting of sponges, however, has attained considerable importance. Virtually all the vessels of the Greek sponging fleet having headquarters at Tarpon Springs, Florida, are so equipped. To this the writer can testify from personal observation of such a fleet forced into harbor at Key West by a hard "blow" in June, 1915.

The use of the diving helmet for submarine biological work would seem to have originated at the Tortugas Station in 1915, but such is not the case. In Quatrefage's *Rambles of a Naturalist*[2] may be found the data given below concerning the apparatus used in a search made by Milne-Edwards over the bottom of the Bay of Taormina on the southern coast of Sicily some time between March, 1844, and June, 1845.

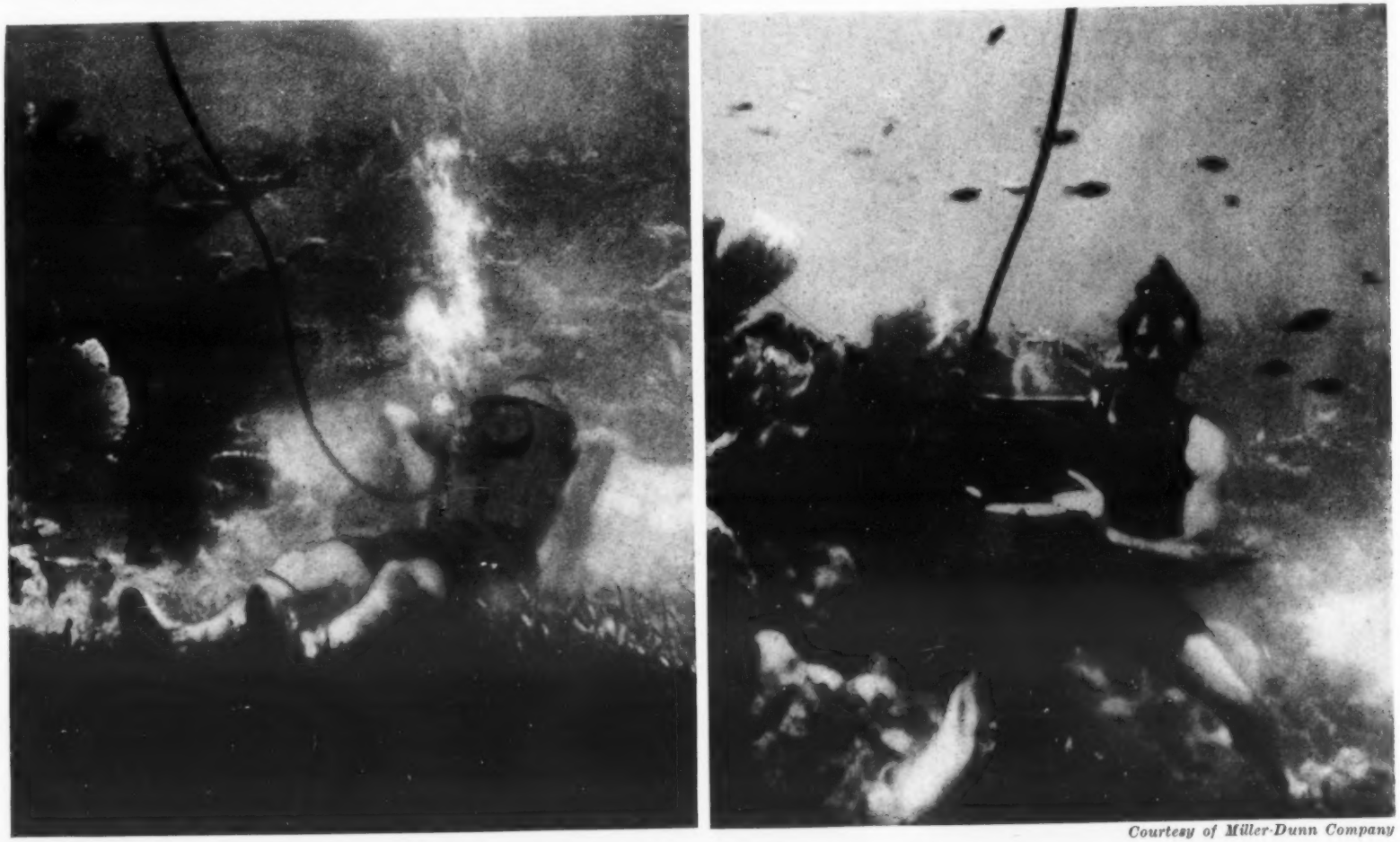
"The apparatus employed by M. Milne-Edwards in these submarine explorations was that which had been invented by Colonel Paulin, a former Commandant of the Fire Brigade of Paris, to be used in case of fires in cellars. A metallic helmet, provided with a glass visor, encircled the head of the diver, and was fastened round the neck by means of a leather frame supported by a padded collar. This helmet, which was in truth a miniature diving-bell, communicated by a flexible tube with the air-pump, which was worked by two of our men, whilst two others stood ready to replace their companions."

The reader probably has come to the conclusion that this was a unique occurrence, the first of the kind in the history of the world, and, used for the purpose Milne-Edwards had in mind, it probably was the first; but history repeats itself. The full or closed helmet diving dress, essentially in its present form, was practically perfected by an Englishman, bearing the German name of Augustus Siebe, in his work on the wreck of the "Royal George" about the year 1839. This, however, was but a perfection of the open

[1] That the use of the helmet alone in diving is not a new thing, and that it did not originate as conjectured, I have ascertained since writing the above. Mr. Ernest Cotton of Marathon, Florida, division engineer of the Florida East Coast Railway, Key West Extension, has been in charge of the underwater work of the over sea railway since its inception in 1906. He informs me that although in his work very extensive use has been made of the helmet alone of the diving dress, it did not originate with this work, but that Key West divers had made use of it for some years prior to its use on the Extension. His men often have worked in forty-foot water with the helmet only, but his understanding is that Key West divers have gone twenty feet deeper without having to put on the full suit.

Even though this use of the diving helmet did not originate as has been conjectured, there can be no doubt that its use was carried to its present perfection in the submarine work necessitated in the building of the scores of miles of concrete work on this remarkable railroad.

[2] *The Rambles of a Naturalist on the Coasts of France, Spain and Sicily*, volume II of which, translated into English by E. C. Otté, was published in London in 1857.



Courtesy of Miller-Dunn Company

BECOMING A MARINE ANIMAL FOR STUDY OF UNEXPLORED TROPICAL SEAS

The diver is free to move about as he wishes to a depth of twenty or thirty feet, and to sit or recline in any position his work demands. As shown at the right, he can remove the helmet while under water (holding his breath in the meantime) and will be kept at the bottom only because he retains the weighted hood in his hands

Courtesy of Miller-Dunn Company

The diving helmet is extremely simple—a brass hood with a handhold at the top, a plate glass window in front, and lead weights below. Professor Longley found about eighty pounds necessary to counteract the buoyancy of the body. This photograph shows Mr. Rex Beach, the author, about to go down in eighteen feet of water

helmet diving dress invented by Siebe in 1819 (the authorities differ as to the date, some assigning it as the year 1829). This consisted of a metal helmet with metal shoulder plates terminating below in a canvas or leather jacket, under the free edges of which the respired and surplus air escaped. This in its turn seems only to have been a refinement of the crude apparatus of Kleingert of Breslau, who in 1798 made use of an egg-shaped metal cylinder which was slipped over the head and trunk of the wearer. This, however, was probably a somewhat modern development of still earlier diving apparatus.

The earliest known figure of a submarine diver attired in his suit is probably that contained in the 1511 or 1532 edition of the *De Re Militari* of Vegetius. This engraving, which I have not been able to locate, is said to represent a diver attired in a leather helmet with a leather tube extending to and supported by a bladder at the surface of the water. Such an apparatus at once recalls an elephant swimming wholly submerged but for the tip of his trunk extending above the surface.

Furnishing a steady supply of air under pressure to the diver seems to have originated with one Borelli in 1679, who attached a simple air compressing pump to such a leather diving helmet as that described above.

All these devices are, of course, but refinements of the crude diving bells used far back in ancient times, in one of which Alexander the Great descended to the bottom of the sea and studied the plants and animals found therein, to be noted as probably the earliest submarine biological observations ever recorded. The earliest account of the use of any sort of diving apparatus is found in Aristotle, who records its use in times dating back to about 1000 B.C.

Probably the latest and simplest, and by far the cheapest, development of diving apparatus for use in shallow water, is that perfected in the diving hood described in this article. So valuable has it been found in submarine biological work at Tortugas that it has been made a part of the permanent equipment of the station there.

Ernest W. Smith: In Memoriam*

A LOVER AND ACCURATE OBSERVER OF NATURE, WITH RARE POWER TO MOUNT BIRDS SO THAT THEY HAD A SEMBLANCE OF LIFE, AND TO REPRODUCE FLOWERS WITH WAX AND COLOR SO THAT THEY HAD THE DELICATE BEAUTY OF THE LIVING ORIGINALS

CERTAIN words are lacking from the English language, among them those that might differentiate between various grades of taxidermists and serve to distinguish between American artists like Akeley, and those well defined as "bird stuffers." So we can only say of the late Ernest W. Smith that he was an unusually excellent and artistic taxidermist, with a keen eye for noting the facts of nature and skilled hands for embodying what he saw in pose or form in permanent materials. He rarely dealt with the larger mammals, and in the early years when he did work with them methods now employed were unknown, but the stately Alaskan moose that confronts the visitor at the entrance to the North American hall in the American Museum shows what he might have done.

His work was directed especially to birds and to wax reproductions of plants and flowers, and was characterized by accuracy and finish. This made his aid invaluable in such pieces of work as the New England spring group and the great Florida group, on the latter of which he was engaged just prior to his death.[1]

Mr. Smith was always pleasantly free from "artistic temperament" or professional jealousy, and this made it possible for him to work in harmony with other taxidermists and to accept and carry out suggestions—and there are times when this is quite as important as purely original work.

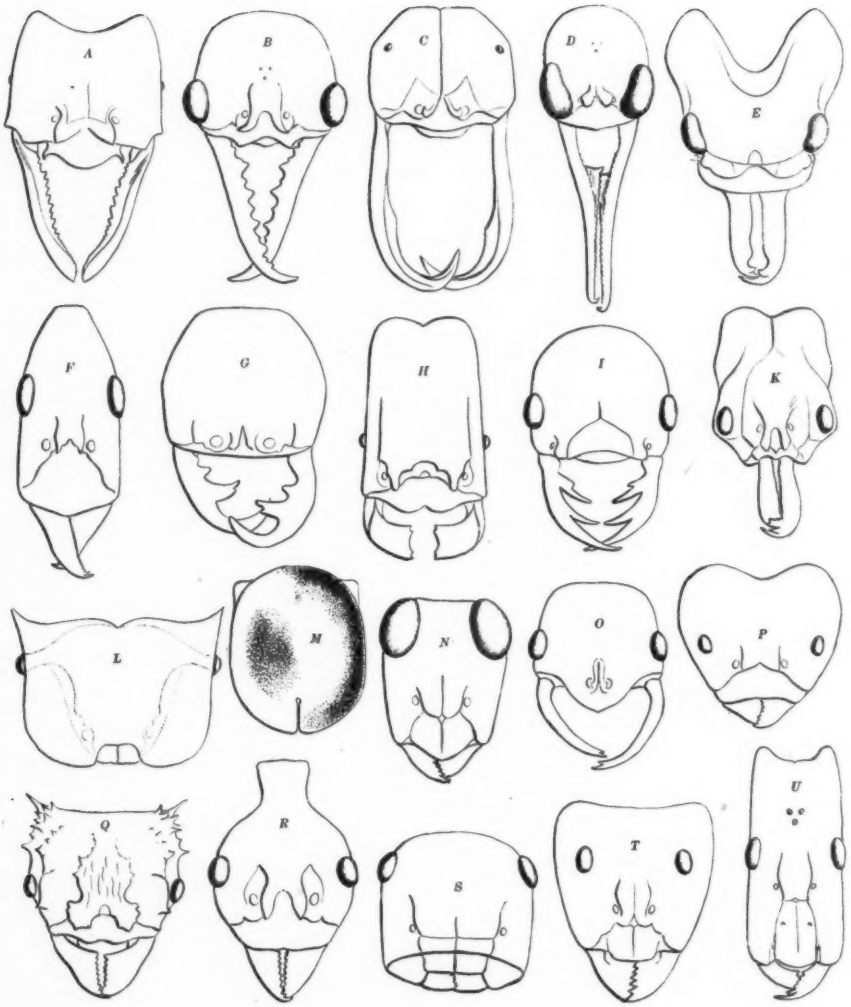
[1] In conjunction with Mr. Frederick H. Stoll, who has continued the work to its completion.

Mr. Smith came to the American Museum of Natural History in 1890 and was there until 1902, when on account of failing health he was forced to seek conditions under which he could devote much time to out-of-door life, and work when best he could. During these later years he mounted in the Brooklyn Museum the group of Pribilof sea birds, in which the individual birds for correctness of form, pose, and expression are unequaled. He also prepared the seasonal groups of wild flowers that form one of the attractions of the Crane Museum at Pittsfield, Massachusetts, and some of the bird groups for the collection of Mr. John F. Thayer in Lancaster, Massachusetts.

The foliage and flowers in the New England spring group in the American Museum testify to his dexterity and power for accurate detail and delicacy of finish. Mr. Smith was one of several who obtained their first knowledge of the technical methods of reproducing foliage from Mrs. E. S. Mogridge who, with her brother Mr. H. Mintorn, prepared the leaves and flowers for the small habitat groups of British birds that were installed long ago in the British Museum, and were the genesis of the large groups of today, but he, like others of Mrs. Mogridge's pupils, improved greatly upon her knowledge and technique.

Mr. Smith will long be missed by those with whom and for whom he worked, as his cheerful, kindly disposition and his deep interest in whatever he undertook made friends of all who knew him.—F. A. LUCAS.

* Mr. Smith stopped work on the Florida group at the American Museum in May, 1917, because of threatening inroads of the tuberculosis he had fought so many years, and died at his home in Dover, New Jersey, October 5, 1917.



HEADS OF VARIOUS KINDS OF ANTS

Not a new assortment of brownies. The jaws or mandibles of ants vary remarkably in form, in accordance with the uses to which they are put. Figures *A*, *B*, *C*, and *O* are piercing jaws of highly predacious ants; *D*, *E*, and *K* are mandibles used in jumping; *H* represents a pair of jaws adapted for cleaning and severing, and *G* and *I* for tearing. The others are of more ordinary types. *M* shows the part of an ant head used in stopping the entrance to a burrow (From Wheeler's *Ants*, by courtesy of the Author and of the Columbia University Press)

The Biting Powers of Ants*

By W. L. McATEE

United States Biological Survey

IF THE title had not been too long, not to say pedantic, this paper might well have been headed "The Natural and Artificial Uses of the Mandibular Powers of Ants," neither would it have been amiss to entitle it "Uses and Misuses of Ant Jaws."

Jaws may be used for many things, and so indeed they must, in the case of most invertebrates, as in addition to the normal functions connected with eating, the jaws form the sole means of prehension, and therefore are the most important medium of contact of the organism with its environment. Mandibles are hands and tools in one, but they have many special uses, and this is particularly true of the order of insects to which ants belong.

It is well known that many of this group (Hymenoptera) maintain their position while sleeping, or in other words, keep themselves in bed, by the use of the mandibles. In Texas two species of bees resort regularly to certain trees for sleeping and firmly insert their jaws into the wood.[1] At a hymenopterous "hotel" at Falls Church, Virginia, two species of bees and three of wasps were observed to sleep on grass stems which they grasped tightly with their mandibles.[2] Enough similar observations have been made to prove that this is a more or less general habit, not only of species in the United States but also of those in other countries. Parasitic Hymenoptera have been found attached by the jaws to their host insects, apparently awaiting a favorable opportunity for oviposition. This has been especially noted in the genus *Scelio*, which deposits its eggs in those of grasshoppers.

Proceeding to ant "jawology" in particular, we may best divide the discussion into (1) The biting powers of ants as used by themselves in their own, or what they consider their own, affairs, and (2) The use by other animals of these powers of ants. In the pursuit of their accustomed activities, ants naturally use their jaws chiefly in ways advantageous to themselves, but good things often are carried too far, and ants in using their jaws furnish no exception to the rule. We therefore have a category of actions which are disadvantageous.

The advantageous uses of the jaws form a part of most of the normal activities of ants: "The mandibles, being the parts with which the ant comes into most effective relations with its environment, present, like the beaks of birds and the teeth of mammals, a bewildering variety of structure. They are used for excavating soil or wood, cutting up the food, fighting, carrying the prey, their young, or one another, and in some species, even in leaping by closing them rapidly against hard bodies. Ants are remarkable in being able to open and close their mandibles independently of the maxillæ and labium."[3]

Mandibles of the normal type "are palmate, toothed along the receding edges, and terminate on the inside margin in a large pointed tooth or tusk. These two opposed instruments, working against each other, form the composite tool and war weapon of ants. With these they dig their galleries in the earth, or carve them out of wood, cut down grass, defoliate trees, seize and cut up food of all sorts. Being palm-shaped as a rule, the gathered and comminuted material can be compressed into their hollows, and so carried as conveniently as in a basket or barrow. As the muscles permit the application of much or little force at the insect's will, the mandibles can be clamped together with power enough to break and tear tough fibres, or approximated so gently that the soft eggs and tender larvæ can be borne about as daintily as an infant in a mother's arms."[4]

Every one has observed trees that have

[1] Observation of Mr. E. A. Schwarz.

[2] Fact reported by Mr. Nathan Banks.

[3] Wheeler, W. M., *Ants*, 1910, pp. 18–19.

[4] McCook, H. C., *Ant Communities*, 1909, p. 206.

* This article by Mr. McAtee was prepared originally to be read before a learned body of scientific men, the Biological Society of Washington ("for their amusement," Mr. McAtee explains); it nevertheless obtrudes no technicalities of language or distracting bibliographical references—although presenting through frequent footnotes the authority for every statement and the original sources for further research by the interested student.—THE EDITOR

been hollowed out by ants and it is apparent that their biting powers are equal to working in the hardest woods. In tunneling, ants are expert, and authentic cases are known of their tunneling under ditches and streams. Indeed a South American ant is said to have excavated a tunnel under the bed of the Parahyba River at a place where it is as broad as the Thames at London Bridge. The nest mounds of ants, entirely the work of their versatile mandibles, are familiar to all. Those made by some tropical species reach an enormous size, but even in the United States, the hills of *Formica fusca* reach a height of four and one-half feet and a diameter of six. In making the gigantic hills of the tropics, the ants tunnel[1] from ten to thirteen feet or more below the surface. It goes without saying that this hastens the decay of the rocks. "The impression one gets from the work of the ants . . . in the tropics, is that they are vastly more important as geologic agents than the earthworms of temperate regions." (Branner, p. 152.)

Aside from their use in constructing nests, the busy jaws of ants find multifarious uses in the normal round of life. All food is gathered by their aid; the eggs and young are tended with solicitous care; and the queen is groomed and fed; the plant lice, the ant people's cattle, are moved from place to place, and shelters are sometimes built over them; the mandibles take part in most features of the toilet of ants—and they are very cleanly creatures; supernumerary males and the dead are disposed of; often the ground about the nest and long trails leading away from it are cleared of all vegetation and obstructions; and in some species "the soldiers bar the entrances to the nest with their heads, and snip intruding ants in two with their strong mandibles."[2] In *Pheidole instabilis* "the soldiers have an office for which their abnormally large heads and strong jaws peculiarly fit them. . . . Their heads are so large proportionately to their bodies, that if turned upon their backs they are often unable to right themselves, and if not relieved may die practically standing on their heads. This big-headedness, with its corresponding development of the jaws . . . has led to a peculiar service. The soldiers act as the communal carvers or trenchers, and crack the shells of the oily seeds and the . . . chitinous cases of the insects which the foragers collect."[3]

All this is mandible work, some functions calling for strength and others for delicacy of action. One domestic phenomenon, in which the mandibles play an interesting part, deserves more extended description. The green wood ant of southeastern Asia (*Œcophylla smaragdina*) makes its nest of leaves fastened together by a fine white web. The adults, however, do not have the power of spinning silk; that is an accomplishment possessed only by their larvæ. The edges of the leaves being held together by the jaws of workers, other workers carry in larvæ which spin fine threads from their mouths. By touching the freshly issuing threads first to one side then the other, in fact using the larvæ as shuttles, the worker ants quickly fasten the seam.

"The assiduity with which ants carry burdens, and especially the grain-collecting habits of various species inhabiting warm countries, led to their being introduced as seed-sorters into fairy tales. We find a typical instance of this in the story of Cupid and Psyche. One of the first of the impossible tasks imposed upon Psyche by the malice of Venus, was the mixing of poppy, vetch, millet, wheat, and other seeds and grains into a large heap, which Psyche was commanded to sort out, each kind into a separate heap. But an ant who was passing took pity on Psyche, and called all its companions to her assistance. They came forth from their habitations in troops, like the waves of the sea, and very soon sorted each kind of grain by itself, and when they had finished the work, they withdrew to their nests."[4]

Among other uses of ant mandibles, falling in the category of advantageous actions, is that of leaping. Leaping seems quite a different function from biting, but as we shall see, it is made possible by the simplest of all the movements of the mandibles—namely, closing them together. "In *Odontomachus*, the 'tic-ant' of the tropics, for example, the linear mandibles are in-

[1] See article by Professor John C. Branner, entitled Ants as Geologic Agents in the Tropics, *Journ. Geol.* Chicago Univ., 8, 1900, p. 151.

[2] Kirby, W. F., *Marvels of Ant Life*, 1898, p. 137.

[3] McCook, H. C., *Ant Communities*, 1909, p. 203.

[4] Kirby, 1898, p. 149. This tale is related in the myth of Eros and Psyche in Apuleius' "The Golden Ass."

serted close together at their bases and provided along their inner edges with a few sense-hairs which are nearly as long as the mandibles. When the ant is excited it opens its mandibles to their utmost extent, till they form together a straight line at right angles with the long axis of the body. Then as soon as a hard object is touched by the sense-hairs, the blades are suddenly closed, striking the object with their tips with sufficient force to throw the insect backwards into the air for a distance of several inches." This habit is also exhibited by several other genera and species with similar mandibles, among them "the large-eyed Brazilian *Gigantiops destructor*, which is able to 'leap from twig to twig,' and an Indian ant, *Harpegnathus cruentatus*, with extraordinary mandibles, which is said to leap forward like a grasshopper to a distance of eighteen inches (Wroughton)."[1] A New Guinean ant only three mm. long can spring on the average forty-seven cm., which is more than one hundred and fifty times its own length.

From remarkable leaping performances it is easy to pass to feats of strength. The following observations[2] were recorded a few years ago:

"While walking on the university campus the other day, my attention was arrested by what appeared to be a grasshopper moving along the sidewalk without using his hind legs. Upon closer examination, I saw that the grasshopper was dead and was being dragged along by a small ant.

The difference between the size of the little laborer and his load was so extraordinary that I thought it might be of interest to know the exact weight of each. I accordingly weighed them carefully on an analytical balance and obtained the following figures:

Weight of ant	3.2 mg.
Weight of grasshopper . .	190.0 mg.

Thus, the ant was dragging a load that weighed approximately sixty times his own weight. This is equivalent to a man whose weight is 150 lbs. *dragging* a load of 4½ tons, or a horse of 1,200 lbs., a load of 36 tons! Is this not somewhat remarkable?"

We must admit that the feat is remarkable, but this record like so many others, has emphatically been broken. An Australian ant (*Myrmecia forficata*) has been known, while suspending itself by its feet, to support in its mandibles a pair of gloves which were more than 1100 times its own weight. Working out equivalents after the fashion above, it is clear that this performance would only be equaled if the one hundred and fifty pound man, hanging by his toes, supported in his teeth a weight of eighty-two tons.

Seriously, however, these feats—the real ones of the ants, I mean—do point toward a conspicuous characteristic of the biting powers—namely, tenacity. This is the thread upon which will be strung most of the remaining incidents in "jawology" I have to cite. The ant just mentioned as supporting the gloves is popularly known in Australia as the bulldog or bull ant, it not being known "whether they most deserve the name of bulldog from the square shape of the head, their pugilistic disposition, or from their tenacity in retaining a hold. They certainly deserve the title by reason of their courage."[3]

The latter trait is common to all ants; fear does not enter their make-up; battle is unhesitatingly entered into with any foe no matter what the odds, and self-sacrifice is a universal rule.

"The mandibles are the principal weapons and these alone in the larger species of *Camponotus* and *Atta* are sometimes employed with telling effect. In the Myrmicinæ and Ponerinæ their action is often supplemented by that of a well-developed sting. Many species of *Formica* spray their enemies with formic acid, or inject it into their victim by moving the gaster forward and centering its tip on the wound made by their mandibles. In battles with other species or aliens of their own species they pull their opponents' legs or antennæ with their mandibles and spray the tense membranes between the joints. . . . In *Polyergus* and *Leptogenys* all the workers have sickle-shaped mandibles adapted to piercing the heads or bodies of their victims."[4]

"This instrument, for the two mandibles work together as one organ— . . . is at once a war-club, battle-axe, and sword; it will decapitate a foe with the facility of a sabre or guillotine, will sever a leg or antenna as deftly as a scimitar, or crush a skull in its formidable vise as would a tomahawk or club. It is terrible to see, in the fierce encounter of emmet warriors, the cruel havoc wrought by this weapon."[5]

[1] Wheeler, *Ants*, 1910, p. 180.

[2] Observations by Mr. Armand R. Miller. *Science*, Vol. 16, N. S., Sept. 26, 1902, pp. 514–15.

[3] Quoted from Mr. E. R. Barker, *Victorian Naturalist*, 20, No. 8, Dec., 1903, p. 105.

[4] Wheeler, *Ants*, 1910, pp. 181–182.

[5] McCook, *Ant Communities*, 1909, pp. 206–207.

The sanguinary character of ant battles is well illustrated by the following account[1] of a conflict in which a small species (*Cremastogaster læviceps*) conquered a much larger kind (*Formica purpurea*).

The larger ants were seized by six or eight of the smaller, "which held on with bulldog-like tenacity, whilst more of their comrades sawed the hapless prisoner into several pieces. When once the small ants get a good hold they never let go, mutilation, and death even, failing to loosen their grip. Many of them were bitten off at the neck by the powerful jaws of the large species, but still the heads remained clamped on to the legs and antennæ of their adversaries."

Ants pursue the same bulldog tactics in capturing living prey. In Bermuda a small red ant is a common enemy of the house fly, as related below:[2]

"This creature attaches itself to the tarsus of the fly by means of its mandibles. It was a matter of common observation to see flies on the wing with these small ants attached. On one occasion I disengaged the ant and placed it on a table. It remained quiet until a fly came within suitable distance, when it made a rush, and was carried off clinging to the leg of the fly. I believe that the attack was made for the purpose of finally eating the fly. The ant hung on until its host became exhausted, and then attacked a more vital spot than the foot, and killed it."

It is probable that this method is effective with a variety of middling size prey, too large to be carried off bodily, but yet small enough to be gradually worn down. I once observed a common spotted cucumber beetle (*Diabrotica duodecimpunctata*) with a peculiar bunch underneath the fore part of the body. Upon examination this bunch proved to be an ant that had grasped both front tarsi (how he got both of them I would like to know) of the beetle in its jaws. Even with this handicap, the beetle was able to crawl up the window pane. It is probable, however, that this incident would have resulted in victory for the ant as the beetle had no means of getting rid of its little tormentor.

Larger prey is clung to in the same way, often by several ants. In India an observer[3] "once caught a butterfly (*Euplœa siamensis*), which was especially conspicuous from its extremely erratic flight, and found that a red worker of the large wood ant (*Œcophylla smaragdina*) had bitten itself fast on its body." Another interesting case describes a struggle between some harvesting ants and a caterpillar:

"I was once a witness of a singular contest between a soft-bodied, smooth, greyish caterpillar, about an inch in length, and two medium-sized *barbara* Ants. The Ants were mere pigmies in comparison with their prey, for as such, I believe, they regarded the caterpillar, but they gripped its body with set mandibles, showing the most savage determination not to lose their hold.

"When I first discovered the group, the war was being waged in a tuft of grass over one of the entrances to the Ants' nest, and the caterpillar was striding along the leaves, and thrusting itself between the culms in the hope to shake off or brush away its little persecutors. From time to time the caterpillar would turn viciously around and endeavour to pluck away its assailants; but though it actually succeeded in stripping, by means of forelegs and mouth, five of the six legs of one of the Ants, which was within its reach, they never loosened their hold.

"At length, a chance movement of mine shook the grass leaf on which they were, and the Ants and caterpillar rolled together down a steep and rocky slope to about four feet distant. They tumbled over and over several times, but still the Ants gripped their prey as firmly as ever.

"The last endeavour of the giant victim was to rub off the Ants by burrowing into the soil; but on uncovering its retreat I saw that their position was still the same. After watching this struggle for twenty minutes, time failed me, and I returned home, carrying with me, however, the combatants. When on my return I opened the box in which they were imprisoned, these bulldog Ants were clinging with mandibles locked as firmly as ever; and now as I write, in death they are clinging still, drowned in a sea of spirits of wine."[4]

The last observation reminds me of the experience we have in examining bird stomachs filled with ants; some of the ants have grasped other particles of food; some their own limbs (and one finds jaws clamped down on nearly severed legs); many seize other ants, and sometimes, when picking out an ant from the mass with the forceps, a whole cluster, like tacks attracted by a magnet, follows—bound together by the death grip of the jaws.

While still holding to the thread of tenacity we cross the dividing line between ad-

[1] By Mr. J. Booth, Fighting Ants, *Victorian Naturalist*, 22, No. 4, Aug., 1905, pp. 75–6.

[2] By Major H. A. Cummins, *Science-Gossip*, Vol. VI, No. 64, London, Sept., 1899, p. 124.

[3] Dr. Erich Haase, *Researches on Mimicry*, Part II, 1896, p. 99.

[4] Wood, J. G., *Insects Abroad*, 1874, p. 447. Observation attributed to a Mr. Moggridge.

vantageous and disadvantageous uses of the jaws. Tenacity within reason brings desirable results, but we have seen that in this particular field of endeavor ants know no limit, hence they sometimes get into trouble. This is usually the case when they attack a larger animal which can defend itself by biting or otherwise. Various insects are occasionally captured with the heads of ants clinging to their legs. A tiger beetle (*Cicindela laurentii*) and several other species have been seen so adorned.[1] Tiger beetles probably have no difficulty in decapitating ants, but they are unable to break up the hard heads themselves.

The same sort of tenacity is illustrated in the story of a slave-holding ant which went home with a dissevered head of an ant clinging to its leg.[2] Professor W. M. Wheeler, of Harvard University, told me that he once came upon a colony of harvesting ants (*Pogonomyrmex molefaciens*) evidently recently visited by an army of driver ants (*Eciton cœcum*). Almost every harvester had several *Eciton* heads dangling from its legs, the bodies having been bitten off.

Another observer[3] relates that on one occasion he had put two ants of the species *Camponotus pennsylvanicus*, which had come from an oak log in his room, into a bottle with a turtle (*Kinosternon pennsylvanicum*), and that they had attacked the turtle and had bitten so hard that the heads remained attached to the turtle's neck after the bodies had been removed. Still another observer[4] tells me that he once collected a ground squirrel in the Southwest that had an ant's head fastened in the edge of one of its nostrils. The part was entirely perforated, and the head swung loose; the animal thus had a veritable nose ring and it was certainly of unique pattern, even if not of so much value as those affected by certain savage tribes. It is rather a common occurrence, furthermore, to collect flickers—birds which dig into ant hills and feed freely on their inhabitants—that have ant heads attached to their wing and tail feathers.

In all these cases, disadvantageous jaw work is illustrated; the ants had bitten off more than they could chew. As a rule they encounter the same state of affairs when they attack man. They may annoy or even severely punish, but ultimate victory lies with the attacked. One scientific gentleman[5] told me of an experience he had with an ant accidentally taken into his mouth with a berry. The little fellow at once set his jaws into the inside of the cheek; in dislodging it, the first pull brought away the thorax and abdomen, but the head remained. At the second attempt the head was brought out but a piece of epithelium came with it.

The driver ants of the tropics, *Eciton* in America, and *Anomma* in Africa, are a terror to every living thing. When they are on the march, those creatures able to flee do so at once, those which lag behind are quickly consumed. These ants at times make things very interesting for man. When their line of march takes in a native house, the owners decamp immediately, and the ants are left in full possession. They soon pass on and these visits are not without advantage to the house dwellers as all cockroaches and other vermin are thoroughly cleaned out.

Another observer[6] tells me that at times when looking among the tree tops for birds, he has been taken unawares by an army of these ants. The soldiers among the driver ants have tremendously developed heads and jaws; their bite brings blood and they hang on until the heads are pulled off. The most interesting feature of their attack is the remarkable unanimity with which they set their teeth into the skin. Whether they accomplish this by mental telepathy or otherwise, the fact remains that several ants scattered here and there over one's anatomy all decide to bite at one particular moment. Considering the severity of their bite we may well believe the observer's statement that a surprise party of this kind fairly lifts a man off the ground.

An African ant of similar habits, the *siafu*, has a broad flat head with crescent-shaped mandibles which it buries in the flesh of its victim and there literally stands on its head. This ant exhibits the same biting habits[7] described for the Central American species. As a result one may have twenty-

[1] Observation by Professor D. E. Lantz.

[2] McCook, *Ant Communities*, p. 200.

[3] Wm. T. Davis, *Journ. N. Y. Ent. Soc.*, Vol. XVI, No. 3, Sept., 1908, p. 196.

[4] Mr. Vernon Bailey, of the United States Biological Survey.

[5] The late Professor F. E. L. Beal, of the United States Biological Survey, Washington, D. C.

[6] Mr. E. A. Goldman, United States Biological Survey.

[7] Authority of Mr. Edmund Heller, African explorer.

five to thirty ants upon him before he realizes their presence. The only remedy is to strip and pull them off individually, and usually each one picked off takes a piece out.

An old fable (one of Æsop's collection, in fact) found by the writer in somewhat altered style among the Creoles of Louisiana, has as its main point the singular effectiveness of a good honest ant bite. Briefly the fable is as follows: A dove seeing an ant struggling in the water threw the insect a leaf by means of which it was able to reach shore. Another day the dove sitting drowsily in a tree was approached by a hunter. As the hunter raised his gun and was about to fire, the ant, taking in the situation, quickly climbed to the man's neck and bit with all his might. With a sharp cry the hunter put his hand to his neck, and in so doing dropped his gun. The commotion aroused the dove which flew off in safety.

Another fable explains how certain ants acquired their thrilling power of jaw. A black ant of Ceylon, called by the natives *coddia,* is said to "bite desperately, as bad as if a man were burnt by a coal of fire; but they are of a noble nature and will not begin unless you disturb them." [1] The reason the Cingalese assign for the horrible pain occasioned by the bite is curious. "Formerly these ants went to ask a wife of the *Noya,* a venomous and noble kind of snake; and because they had such a high spirit as to dare to offer to be related to such a generous creature, they had this virtue bestowed upon them that they should sting after this manner. And *if they had* obtained a wife of the *Noya,* they should have had the privilege to sting full as bad as he." The "Noya" is, of course, the well-known Naga, or cobra de capello.[2]

In the categories of biting thus far considered, the ants were in no sense the tools of other creatures; they were doing just what they pleased. The fact that they sometimes lose their lives in misguided ventures does not alter the entirely volitional character of these attempts. But the mandibular powers of ants are put to use by other animals, chiefly by man. Some of these uses are praiseworthy, others are decidedly the reverse. The terrific biting powers of some tropical ants, together with the abundance in individuals of these species, have prompted their use not only in moderate punishments, but also in revolting forms of torture and execution. It has been found [3] that in British Guiana biting ants are used in certain ordeals and in punishing youngsters. The ants are placed in the interstices of specially woven mats, and held there by stretching upon the handles. These ant mats are then applied to various parts of the body of the victim, where the ants naturally bite their best, thus carrying out the wishes of the monitor. There is an account [4] that among the Mundurucu and related tribes of Brazil, biting and stinging ants are used to test the courage of the young men. Bark cylinders half full of ants are put on a young man's arms, and while enduring the most fiendish biting and stinging, the victim must go about the village paying his respects to various householders and officials, showing no signs of distress. From the fact that the fire ant or *tecandiero* is preferred, it is certain that the stinging is more essential to the complete success of this ceremony than the biting.

Ants are used even as executioners. In Burma the criminal is usually tied to a tree, smeared with honey, and left to be devoured by the ants. The Kafirs of South Africa used to stake down their prisoners upon an ant hill, "and they were eaten atom by atom in a few hours." [5]

Passing to less exciting but more praiseworthy uses of the biting powers of ants, we must remember their utility to science in cleaning skeletons. Those who have tried this method know that a beautifully cleaned, but still articulated skeleton is the result. Their proficiency in this occupation is sometimes painfully obtruded upon the zoölogical collector.[6]

It is stated that during pioneer days in the Southwest, it was a custom to throw clothing upon an ant hill, for the purpose of freeing it from the vermin frequently an unavoidable accompaniment of mining camp

[1] Quoted from Knox.

[2] Kirby, 1898, pp. 146–7.

[3] By Dr. W. E. Roth, *Journ. Roy. Anthrop. Inst.,* 42, 1912, p. 539.

[4] By Captain Mayne Reid, *Odd People,* pp. 134–6.

[5] Authority of Sir Richard Burton. Kirby, 1898, pp. 134–5.

[6] Mr. Heller states that the *siafus* often completely consumed the catch of his entire line of traps, the skeletons only remaining. Messrs. Nelson and Goldman became acquainted with a Mexican ant which had a very precise formality to be accomplished before actual skeletonizing began. The hair of the specimens was all bitten off close to the skin, leaving the mice and other small mammals looking as if they had been shaved.

life. We have it on the authority of an army surgeon, that "one of the best examples of scavenger work of the ant" may be had by taking a bed ridden with bedbugs, or better, a mattress, and placing it over an ant heap. Every nook and crevice will be cleansed of eggs and bugs in a fashion that will put disinfectants to shame.[1] Ant colonies are placed under houses in China so that the ants may destroy the termites that infest them.

The most interesting use of ants by man that I have so far learned about is in surgery. I present part of an account given by the director of the Laboratory of the Medical Faculty of Paris:[2]

"The mandibles of ants and of several coleopterous insects, *Scarites* in particular, have long been employed in Asiatic surgery. This usage is of the most ancient date with the surgeons of India and is perpetuated in our day in Algeria by the Arab operators and to some extent by the Turks in Asia and the Greek barbers of Smyrna.

"According to an English entomological journal,[3] the barber presses upon the edges of the cut with the fingers of the left hand and applies each ant by means of forceps held in the right hand. The mandibles of the ant are widely opened, the animal being in the defensive attitude, and as the insect is gradually brought near the wound it seizes the projecting surface . . . and immediately forces its mandibles through the flesh . . . and remains in this attitude, pressing the one mandible against the other with force and consequently holding the two edges together. Then the barber separates the head from the thorax with a snip of the scissors, and the head with the mandibles remaining in place continues its function while the thorax and abdomen fall to the ground.

"The same operation is repeated with other ants until at times there may be a dozen pairs of mandibles placed at regular intervals, so that through its whole length the skin is united by this very ingenious procedure. The heads are allowed to remain a few days, after which, since the healing has been effected, they are loosened and having performed their office are henceforth useless."

It is stated on good authority[4] that in Brazil the savages use this species "for holding together the edges of a wound. . . . Then they tear away the abdomen and the thorax leaving only the head at the edges of the closed wound. It is not rare to see among the Brazilian natives one who has a wound in which the process of healing is assisted by the heads of 7 or 8 of these ants" (p. lxvii).

I know of but one instance of the use of the mandibular powers of ants by any animal other than man, but this single instance is decidedly interesting and I believe indicates that future observations will bring to light other similar phenomena.

The observation is as follows:[5]

"The occupants of a recently disturbed ant hill were excitedly crawling about the hill and the adjacent cement walk. They were large, and to a blue jay in a neighboring tree they must have looked luscious, for flying down, the jay began to pick them up with an eagerness that seemed to say that this was an opportunity that might come his way but once. As rapidly as he could do it he seized the ants, with each capture lifting a wing, sometimes one, sometimes the other, and seemed to deposit his prey amongst the feathers back of and underneath it. So quickly he worked and with such evident eagerness to make the most of this rare occasion that, as he lifted the wing, putting his bill amongst the feathers, it often seemed that he must lose his balance and topple over backwards. But he kept his poise, worked on with all speed and had laid in quite a store when a passerby frightened him from his task."

There can be no doubt that this bird was taking advantage of the biting-on habit of ants to attach a number of them to its feathers. What the ultimate object of the action was can only be learned from further observation.

To sum up, the biting powers of ants are brought into play in practically every activity of these insects; to themselves the more delicate functions of the mandibles, as well as their most powerful piercing, cutting, and crushing uses, are valuable. To other animals the strong biting powers and especially the jaw locking habit of ants seem most important. The adaptation of these qualities of ants to ordeals and executions is ingeniously cruel, and their use in surgery by savage tribes is wonderful. What then shall we say if it is confirmed that an animal lower than man has learned to turn to its advantage the instinctive death grip of ants?

[1] Capt. P. L. Jones, *The Military Surgeon*, 27, 1910, pp. 78–79.

[2] Baudoin, M., The Use of Ants in Operative Medicine. *Rev. Scient. du Bourbonnais*, 11, 1898, pp. 252–253.

[3] Mr. R. M. Middleton who wrote the article in an English entomological journal referred to by Dr. Baudoin, gives the name of the species of ant used in Asia Minor as *Cataglyphis viatica* Fabr. A South American leaf-cutting species *Atta cephalotes* L. is known to be used for the same purpose.

[4] M. E. Moquerys in the *Bulletin of the Entomological Society of France*, meeting of October 23, 1844.

[5] By Grace Ellicott of Newcastle, Ind., Note on the Food of Blue Jay, *Guide to Nature*, I, No. 5, Aug., 1908, p. 168.

". . . FOR OF SUCH IS THE KINGDOM OF GOD"

Mural decoration, by Will S. Taylor, mural artist at the American Museum of Natural History. Presented to the City Park Chapel, Brooklyn, by Mr. Frederic B. Pratt

Mr. Taylor has recently painted a decoration for the City Park Chapel, Brooklyn, which is so genuine and sympathetic in its presentation of child love that the JOURNAL considers itself fortunate to be able to reproduce the accompanying photograph taken in the studio at the Museum before the removal of the painting to the church. Any black and white reproduction carries a poor conception of the picture, however, as the color is handled with great charm. It is a pleasure also to quote in full, with the permission of the Art Editor of the *New York Times*, the notice of the decoration which appeared in the *Magazine Section* of this newspaper October 28, 1917. A most interesting suggestion is made in this appreciation of Mr. Taylor's work, namely, that the American Museum, in its murals and group backgrounds, is in line to create a new school of historical painting. In this school, the work will not necessarily lose in atmosphere and poetic influence compared with the standards of art, this depending here as everywhere on the personality and power of the individual artist; it will gain in never departing from a basis of truth.—THE EDITOR

A New Type of Mural Painting[1]

Critical note relative to the decorations in the North Pacific hall of the American Museum

"THE mural decorations by Will S. Taylor at the American Museum of Natural History have attracted attention by their freedom from convention and their mural quality. The artist has just completed a mural painting for the City Park Chapel in Brooklyn in which he has followed the same general course as in the Museum paintings and produced a decoration that is quite personal and unhackneyed, although based upon a theme, Christ blessing little children, that has been a subject for artists through many centuries.

"The chief interest of the painting for students of art is the management of the light and shade. The easiest way to get a mural decoration to seem a part of the wall upon which it is placed and not a hole through the wall or a relief detached from it, is to treat the composition like a map, tying the parts together with a strong bounding line surrounding the larger patches of color, after the fashion of designs for stained glass windows. It may be taken for granted that to be satisfying to the observer the decoration should seem a part of the architecture of the building, but there are other ways of solving the problem. Mr. Taylor treats his composition in the spirit of the sculptor carving his wall in low relief. He permits little reflected lights to bring out the salient forms of his design and his figures have a look of solidity, and nevertheless keep well within one plane. He also pays attention to character. There is no halo and no religious mystery in his picture. The Christ, friendly and benignant, has come to a public square surrounding a well, where the children play and the mothers congregate for gossip, according to the custom in Eastern countries, where the drawing of water is the important feature of the day's occupations. He is seated among the children and is talking affectionately to those nearest, while others stand about in attitudes of interest and curiosity, as they might today in any of the east side streets where something out of the common was attracting their attention. The gestures and poses are entirely natural. The little girl at the left holding a baby in her arms might be duplicated any day in the poorer quarters of New York.

"The artist has, in fact, picked up his models here and there from among the young visitors to the Museum or the children he has observed in the neighborhood. The costumes have been made for him with as close an approach to archæological accuracy as could be managed, but they clothe the figures naturally and have none of the artificiality of reconstructed history. The picture is flooded with sunlight, which streams over the buildings in the background and makes bright patches on the pavement in front of the well. This letting the spirit of out-of-doors into a church also is a modern note. The greens and blues and yellows of the color scheme are skillfully managed and make a strong harmony. Without making any pretense of greatness, the whole decoration speaks of sincerity and the delight of the painter in his work. It would not be surprising if a distinct type of mural decoration grew out of the work done in the American Museum of Natural History. The painters working there are surrounded by objects of the past, not as they are represented in art, but as they are discovered and preserved for precise study, and their special concern is to place these objects in a natural environment. They have as much of nature as can persist through the disintegrating processes of time to suggest color and form, and many contrasts and resemblances. In the mineral section alone are palettes ready set with colors in beautiful and extraordinary relation. And they have for their benefit, as well as for their hampering restriction, an atmosphere of respect for actual fact which discourages much indulgence in poetic license. Even if no masterpieces are created in such an environment, there probably will be enough interesting and well-considered compositions to form a distinct school of historical painting wholly different from the empty and dull imaginings of the earlier historical painters. Holman Hunt and the young Millais would have a good word for Mr. Taylor's methods."

[1] Quoted from the Magazine Section of the *New York Times*, October 28, 1917.

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WELCOMING CEREMONY OF THE BELLA COOLA INDIANS

The murals in the North Pacific hall of the American Museum, executed by Will S. Taylor, already have won distinction and praise, especially for their color and composition values. There are two series of these murals completed. Six panels on the west side of the hall tell stories of Indian industries; a second six, ceremonial in character, run the length of the east wall. A preliminary study for the sixty-foot canvas to occupy the full width of the south wall is at present on exhibition at the New York Architectural League

Museum Notes

SINCE the last issue of the JOURNAL the following persons have been elected members of the American Museum:

Benefactor, MR. J. P. MORGAN.

Patrons, MRS. CHAS. B. ALEXANDER * and MR. JOHN E. THAYER.*

Fellows, MRS. GEORGE BARTON FRENCH * and MESSRS. GEORGE BARTON FRENCH,* LEWIS A. PLATT,* MORTIMER L. SCHIFF,* and CHARLES STEELE.*

Life Members, MRS. HENRY R. HOYT, MRS. RALPH SANGER, MISSES JOSEPHINE ADAMS OSBORN, ALICE LEE WELCHER, AMY OGDEN WELCHER, and EMMA PARK AVERY WELCHER, and MESSRS. EDWARD G. ACHESON, W. W. ATTERBURY,* HENRY BALFE,* DAVID L. BRAINARD,* REGINALD BROOKS, HENRY G. BRYANT,* ROBERT A. CHAMBERS, E. W. CLARK,* HENRY DODGE COOPER,* GRENVILLE T. EMMET,* C. W. GORDON,* GEO. M. GRAY,* LEVI H. GREENWOOD,* HENRY HORNBLOWER,* M. J. LOOK,* CHARLES F. MATHEWSON,* PAUL B. MORGAN,* EFFINGHAM B. MORRIS, JAMES C. PARRISH,* SAMUEL T. PETERS,* LOUIS A. SHAW,* CHARLES A. STONE,* W. B. THOMAS,* PAUL TUCKERMAN,* EDWIN S. WEBSTER,* FRANK G. WEBSTER,* and R. H. WILLIAMS.*

Annual Members, MRS. L. LUYKX VAN OOSTERZEE, MRS. JENNIE E. B. WEBSTER, MRS. MAURICE WERTHEIM, MISS HENRIETTA M. SCHWAB, the REV. H. G. ENELOW, DR. ARTHUR HASTINGS MERRITT, and MESSRS. JOHN H. ABEEL, HAROLD G. ARON, GEORGE BENDER, HENRY KELLY BRENT, STANLEY W. DEXTER, WM. H. EDDY, JAMES M. EDWARDS, WILLIAM FOX, THOMAS A. HOWELL, HOWARD MCWILLIAMS, HENRY B. REED, A. T. SIMPSON, J. J. SLOCUM, PHINEAS SONDHEIM, and NEIL A. WEATHERS.

Associate Members, MISS LYDIA T. MORRIS, DR. LLOYD P. SHIPPEN, and MESSRS. WILLIAM MACRUM, F. CORLIES MORGAN, S. ROWLAND MORGAN, F. W. MORRIS, JR., C. S. W. PACKARD, M. L. PARRISH, H. W. RAYMOND, JAMES M. RHODES, WILLIAM BIDDLE SHEPPARD, CHARLES S. STARR, J. BARTON TOWNSEND, WM. HENRY TROTTER, CHARLES WHEELER, and CHARLTON YARNALL.

A MEMORIAL service for the late Mr. L. P. Gratacap was held in connection with a meeting of the New York Mineralogical Club in the American Museum on the evening of January 16. Numerous tributes to the lovable character of Mr. Gratacap and to his scientific attainments were made by friends and associates present. A collection of his writings which was placed on view shows a very considerable range of subject as well as the great amount of valuable work accomplished.

THE cover design of this number of the JOURNAL, "A Characteristic Reef Scene," is from a copyrighted photograph taken in about ten feet of water by Professor W. H. Longley at the Marine Biological Laboratory, the Tortugas. The massive coral at the right is about four feet high; the fishes, about eight inches in length. Both the more numerous yellow and the common grunts (*Hæmulon sciurus* and *plumieri*) are nocturnal species. They rest during the day as indicated, but scatter over the reefs at dusk to forage individually. Both are changeable in color. The common grunt, in particular, adjusts its shade accurately to that of the underlying bottom.

IN appreciation of his many generous contributions and of his continued interest in the work of the Museum, Mr. J. P. Morgan was elected benefactor at a meeting of the board of trustees of the American Museum held on February 4.

THE JOURNAL wishes to call attention to the list of research associates appearing on the inside of the front cover under the scientific staff of the American Museum. It is as follows: In anthropology, Dr. J. Howard McGregor and Mr. M. D. C. Crawford; in ethnology, Dr. George Bird Grinnell; in vertebrate palæontology, Dr. Charles R. Eastman; in geology, Mr. W. Elmer Ekblaw; in physiology, Mr. Alessandro Fabbri; in mineralogy, Dr. George F. Kunz; in coleoptera, Mr. Charles W. Leng; in annulata, Dr. A. L. Treadwell. Through the interest of these men, the Museum derives great benefit along special lines of scientific research; and the large significance of their work and the importance of their connection with the institution cannot be overemphasized.

* Honorary election in recognition of support of Crocker Land Expedition.

Attention is called also to the use of the title honorary curator in connection with the names of Prof. Henry Fairfield Osborn, Dr. W. M. Wheeler, and Dr. Bashford Dean. This title is now reserved for men who formerly have been at the heads of departments and are still connected with the research and scientific work of the Museum.

"FOREIGN Monuments, Their Erection, Protection, and Restoration," was the subject under consideration by the American Scenic and Historic Preservation Society, which met in the main assembly hall of the American Museum on the evening of January 17. Addresses were made on: "Protection and Destruction of Historic Monuments," by Edward Hagaman Hall; "Care of Allied Soldiers' Graves," by Colonel Henry M. Sackett; and "Ancient Monuments of China and Tibet," by Roy Chapman Andrews. Each lecture was accompanied by many beautiful illustrations on the screen. The following is a copy of a resolution adopted at this meeting:

Resolved, That the American Scenic and Historic Preservation Society and the American Museum of Natural History, meeting in conjunction, desire to extend to the President of the Republic of China their felicitations upon the plans that have been made for the protection of Chinese monuments and antiquities from vandals, and the collection of these priceless relics of the history of China. We renew the expression of our hope that these collections may be safely preserved in a national museum.

Following the memorial which was addressed in nineteen hundred fourteen to the Government of China by fifty-two American institutions of art, learning and humanity, the members of our institutions desire to renew the pledge that we shall use all our influence to prevent the despoiling of China by the unauthorized sale of ancient works of art. We also believe that it is the duty of the civilized countries of the world, so far as possible, to return to China her ancient historical national monuments and antiquities for proper preservation under national custodianship.

A NEW anthropological publication, to be known as the *Journal of Physical Anthropology*, has been established with editorial offices at Washington, D. C. Dr. Ales Hrdlicka will be editor in chief of the new journal and among the associate editors are Dr. Clark Wissler, curator of anthropology in the American Museum, and Dr. J. H. McGregor, research associate in anthropology in the American Museum and associate professor of zoölogy at Columbia University.

THAT whale meat may form an acceptable addition to the diet was well demonstrated at a luncheon tendered to thirty guests of the American Museum by Professor Henry Fairfield Osborn on Friday, February 8, where whale *hors d'œuvre*, whale *pot au feu*, and planked whale steak were the prominent features of an attractive menu. A small model of the humpback whale, which is the kind most frequently captured and which makes the best eating, decorated the center of the luncheon table. The luncheon was arranged to call attention to a large possible source of meat supply which has not yet been taken into account by the food administrators. The 15,000,000 pounds of meat obtained by the capture of one thousand or more whales annually on the Pacific Coast are now used only for fertilizing the soil. Whale meat is said to be equal in food value to beef, and could be marketed in New York City at twelve and a half cents a pound. The Victoria Whaling Company furnished the steak for the luncheon, which was prepared and served by Delmonico. Among the guests were: Mr. Arthur Williams, New York City Food Administrator, Mr. Roy Chapman Andrews, the authority on whales at the American Museum, through whose effort whale meat as a war food has been brought to the attention of the Food Administration of the United States, Admiral Robert E. Peary, Dr. Frederic A. Lucas, and Messrs. Charles H. Townsend, Herbert L. Bridgman, Caspar Whitney, William T. Hornaday, George H. Sherwood, Bashford Dean, Louis Wiley, William Fellowes Morgan, Severo Salcedo, Don C. Seitz, and Charles M. Puckette.

THE American Museum received a visit in December from M. Alphonse Mathey of Dijon, France, who came with a letter of introduction from Mr. Barrington Moore, associate curator of woods and forestry, with whom he has been closely associated abroad. A series of lantern slides for use in the soldiers' camps was presented by the Museum to M. Mathey. These slides included subjects taken from the American Museum and scenes in various parts of the country from San Francisco to New York.

RÉNÉ JUST HAÜY,
de la Legion d'Honneur et de l'Institut National,
Professeur de Minéralogie au Muséum d'Histoire naturelle.
Né à St Just, en Picardie, le 28 Février 1743.
Traduit du dessin de F. Maffard.
par R. D'Heaux. Sc.
"Au Savant Auteur des Traités de Physique et de Minéralogie"

ON February 28, 1918, the American Museum of Natural History, in coöperation with the delegates from the New York Academy of Sciences, Section E of the American Association for the Advancement of Science and the New York Mineralogical Club, will hold a memorial meeting at the American Museum of Natural History in honor of Abbé Réné Just Haüy, 1743–1822, the great French crystallographer. Papers are expected from Edgar T. Wherry, Edward H. Kraus, George F. Kunz and others, and one written for the celebration by the late L. P. Gratacap will be read. Portraits of Abbé Haüy and the Haüy Frères, as well as mineralogical books of the eighteenth and nineteenth centuries, will be shown.

AN important addition to the American Museum's collection of Asiatic insects has been made through the presentation by Mr. Harry E. Caldwell of the large number of specimens collected by him in China. The gift is of particular value because of the previously small representation in the Museum of insects from this most interesting region.

A SERIES of lectures by Professor A. L. Kroeber was given in the American Museum during the month of January. Professor Kroeber discussed the traits of culture of each of four native tribes of California, two in the northern and two in the southern part of the state, whom he classified as legalists (the Yurok), indifferents (the Wintun), mystics (the Luiseño), and dreamers (the Mohave). It was shown that these four Indian groups, all within the boundaries of one state and usually considered as among the lowest in the scale of primitive peoples in this country, are as distinct from one another in their philosophy of life as are the peoples of any four countries of Europe.

Two interesting fish groups are nearing completion in the department of preparation of the American Museum. One, featuring a large blue shark with a brood of young, presents a scene in the deep currentless region

of the Atlantic known as the Sargasso Sea, where the drifting gulfweed comes to rest, scattered loosely about or forming great yellow fieldlike masses. The blue shark, which grows to a length of about ten feet, is perhaps the commonest surface shark of the open ocean. It is a beautiful blue above, matching the color of the sea, and a dazzling white below, slender and graceful in all its lines. Many problems of lighting had to be contended with in this group, to make a satisfactory view below the surface of blue offshore waters. When seen from below, the surface of the water is an almost perfect mirror. By introducing an actual mirror a more realistic effect has been obtained than could have been produced in any other way. Material is being assembled for an adjoining group designed to show protective adaptations of smaller pelagic fishes, many of which hide in the drifting gulfweed, which they resemble so closely as to be almost invisible, or seek protection about the powerful stinging tentacles of a bright-colored "Portuguese man-of-war."

SIX beautiful specimens, three of opal and three of tourmaline, have been added to the gem collection of the American Museum through the generosity of Mr. J. P. Morgan. The three opals, which glow with shades of green, red, and blue, are from Humboldt County, Nevada. Two of the tourmaline specimens, of the rose red or pink variety, are from Minas Geraes, Brazil; the third, a large uncut piece, is from San Diego County, California.

THE entire series of carved ivories collected by Mr. Herbert Lang during the American Museum's Congo Expedition is now displayed in the gem hall of this Museum, where it occupies a twenty-eight foot wall case. The exhibit is fittingly placed in this hall, as the ivories are in the nature of crown jewels to the African chiefs. Whenever a native shows aptitude for carving he is immediately attached to some chief and uses his talent for him alone. The size and importance of the collection made during a chief's lifetime are an indication of his rank. When he dies the carvings are destroyed, which accounts for the fact that no very old objects are to be found. The exhibition includes large carved and etched horns, ornamental hair combs, arm bands, weapons, bowls or cups, knives and forks, mortars and pestles, fine ivory pins, and ceremonial objects—all showing remarkable skill in carving and many of them exceedingly rare.

RUSSELL J. COLES, who has spent several weeks on the coast of southwest Florida in reconnaissance of the possibilities of winter shark and ray fisheries, tells us that these large fish, formerly wasted, are now being shipped from that field to northern markets. He looks forward to great expansion of the shark and ray output along our entire coast within the next few months, and a significant addition from this source to the nation's food, leather, and oil supplies.

MR. ROY CHAPMAN ANDREWS, associate curator of mammalogy in the American Museum of Natural History, was elected corresponding member of the Zoölogical Society of London at its meeting on December 19, 1917.

DR. EDMUND OTIS HOVEY represented the American Museum at the annual meeting of the Geological Society of America, in St. Louis, December 27–29. The meeting was well attended considering the disturbed condition due to the war, and many papers of scientific interest and some of direct bearing on the relations of geology and geologists to the conduct of the war were presented. After the meeting Dr. Hovey visited the important new lead and zinc mining district of northeastern Oklahoma, and made arrangements for the collection and transfer to the American Museum of material illustrating the beautiful grotto developments of the ores growing in the mines there.

DR. BASHFORD DEAN of the Metropolitan Museum of Art and the American Museum, now Major of Ordnance in the United States Army, returned from Europe in January.

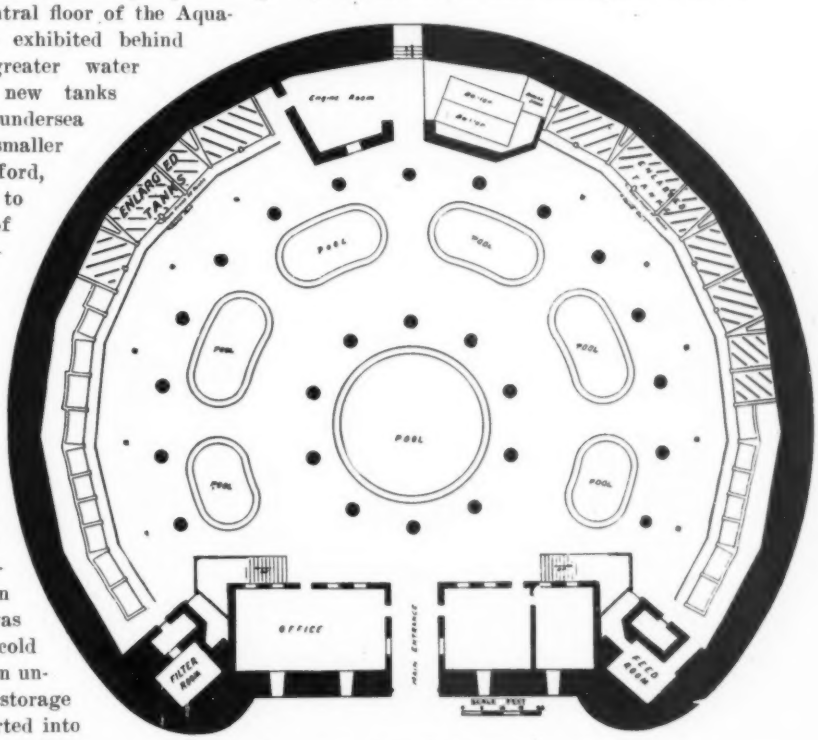
DR. C-E. A. WINSLOW, of the department of public health of the American Museum, was awarded a presentation medal by the National Institute of Social Sciences at its meeting on December 18, for his services to the cause of public health.

MRS. ELSIE CLEWS PARSONS, who for several years has been carrying on independent investigations in the social organization and ceremonies of the Zuñi and other Pueblo Indians, has signified her willingness to be-

come a volunteer worker under the direction of the department of anthropology of the American Museum. She will give particular attention to the important ceremonies of the Indians, in order to determine how far these may have been influenced by Spanish culture, particularly by the teachings of the church fathers. Mrs. Parsons is now on her way to Zuñi to begin this work.

THE New York Aquarium, under the directorship of Dr. Charles H. Townsend, has increased its attractiveness, as well as its usefulness, by the enlargement of several of the glass-fronted exhibition tanks on the ground floor of the building. The original tanks, built of heavy masonry, were only seven feet long and four feet from front to back. By removing the partitions between some of these small tanks larger ones were made, averaging fifteen feet in length. The rear walls of the tanks were then extended to the outer walls of the building, giving a depth of twelve feet. Thus space was obtained in which could be shown a larger number of species for each tank; also sharks and sturgeons, formerly kept in large pools on the central floor of the Aquarium, could be exhibited behind glass. The greater water space in the new tanks produces an undersea effect which the smaller tanks did not afford, and adds much to the appearance of the exhibit, besides greatly improving conditions of life for the occupants. In order to make two of the enlarged tanks of the fresh-water series available for salt-water exhibits, an extension of piping was made. When cold weather came, an unused wooden storage tank was converted into a water heater, which made it possible to exhibit in this water system many local sea fishes not to be found along our shores in winter. This improvement is especially valuable, as marine species of fishes and invertebrates are much more numerous than fresh-water species, and should be given a larger representation in the collection than has hitherto been possible. Due to Dr. Townsend's personal initiative and effort in the work, eleven of the new enlarged tanks are already open for exhibition and an additional four are under construction.

A PAPER by Mr. G. K. Noble, ready for publication, covers the Nicaragua amphibian collections of the American Museum. Of the twenty-seven species two are described as new, and four others are reported for the first time from Nicaragua. Many of the species are rare in collections. *Hyla boulengeri*, which formerly was known only from the type, is represented by three specimens. It is interesting that one of the new species, a semi-arboreal salamander, should have been taken at several widely separated localities. The Nicaragua Ornithological Expedition, 1917, collected one specimen on Mt.



Ground plan of the New York Aquarium, showing position of the enlarged exhibition tanks

Mombacho in the west, while the Nicaragua Reptile Expedition, 1916, found the species almost at sea level in the east.

MR. LEO H. MILLER, assistant in ornithology in the American Museum, is now located at Fort Sill, Oklahoma, where he is engaged on active duty as lieutenant in the Aviation Corps of the United States Army. His inclusion in last month's JOURNAL among those commissioned in the infantry was an error.

THROUGH the courtesy of Mr. John M. Hoffmire, of Newark, New Jersey, nephew of the late Titian Ramsay Peale, naturalist and artist, the library of the American Museum is the recipient of a very valuable unpublished work prepared by Mr. Peale. This consists of a book of colored sketches of Lepidoptera and their larvæ with the plants upon which they feed. The sketches, which are accompanied by written descriptions of the subjects, bear dates ranging from 1833 to 1880.

THE AMERICAN MUSEUM has acquired by purchase about one hundred and fifty pieces of pottery taken from a single ruin near Adamana, Arizona. This pottery portrays a type of ware and decoration hitherto represented but little in the collections of the institution. A dugout canoe, made many years ago by the Indians of Ulster County, New York, is another fortunate acquisition. The canoe is in an excellent state of preservation.

AN exhibit of birds used in falconry, on the second floor of the American Museum, is attracting the attention of those interested in mediæval practices. The birds in the exhibit range from the small hobby falcon, used by the young squires in the pursuit of small game, to the large golden eagle, capable of carrying away a small mountain goat. The taming and training of birds of prey for sport was practiced in China as early as 400 B.C., and although it was not introduced into Europe until much later, it had become the usual custom in western Europe and England by the end of the ninth century. In the language of falconry the term "falcon" was applied only to the females; the males, which were about one third smaller, being called "tiercels." In Shakespeare's time everyone who could afford to do so kept a hawk, and the rank of the owner was indicated by the species of bird which he carried. To a king belonged the gerfalcon; to a prince, the falcon gentle; to an earl, the peregrine; to a lady, the merlin; to a young squire, the hobby. A yeoman carried a goshawk; a priest, a sparrow-hawk; and a knave, or servant, a kestrel.

WHEN an attempt was made in 1917 to introduce into England the practice of selling song birds in the food market, the Royal Society for the Protection of Birds quickly interfered. The custom is common in southern Europe and northern Africa and once was prevalent in our own state of Louisiana. In England, however, larks are still sold legally and in large numbers in open season.

A PLAN to restore the bird population of France is advanced by M. André Godart in a book entitled *Les Jardins Volières*. M. Godart calls attention to the scarcity of birds in France, due to insufficient protection, and the consequent loss to grape growers of the Gironde in 1910 of forty millions of francs, as well as a decrease in the oil production of southern France so great that the olive growers threatened to abandon the industry. He suggests that goldfinches, bullfinches, linnets, yellow-hammers, thrushes, blackbirds, and starlings, all of which nest readily in gardens, be reared in large and specially designed aviaries and released when full grown to repopulate the now deserted woods and fields.

THE department of geology has just acquired two important collections of invertebrate fossils, principally from the famous fossil coral reefs at the falls of the Ohio, near Louisville, Kentucky, and from other important localities in the Middle West, many of which have now been exhausted or otherwise rendered unproductive. One of these is the George K. Greene collection, comprising some four hundred thousand specimens including about five hundred types of the species of corals which were described by Mr. Greene. Mr. Greene was an industrious collector of the old school, being contemporary with Collett, Bassett, Meek, Worthen, and other well-known collectors and palæontologists of the Middle West in the last century. The other acquisition is the Wm. J. McConathy collection, which consists of about seven thousand specimens, principally silicified fossil corals from which the limestone matrix has been carefully etched away with acid.